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(54) **ELECTRICAL CONDUCTOR WEDGE CONNECTOR SPLICE**

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H01R 11/01 (2006.01)

(52) **U.S. Cl.** **439/783**

(58) **Field of Classification Search** 439/783, 439/784, 796, 863
See application file for complete search history.

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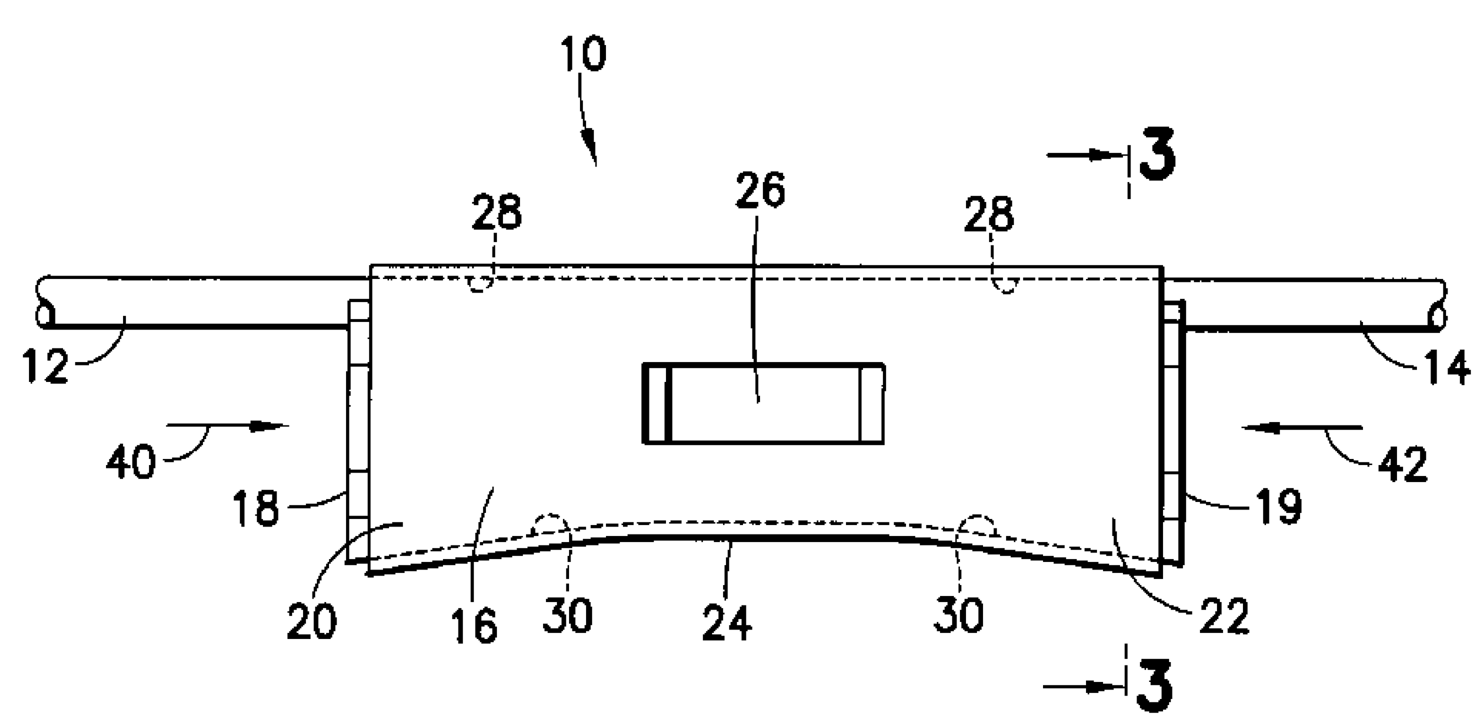
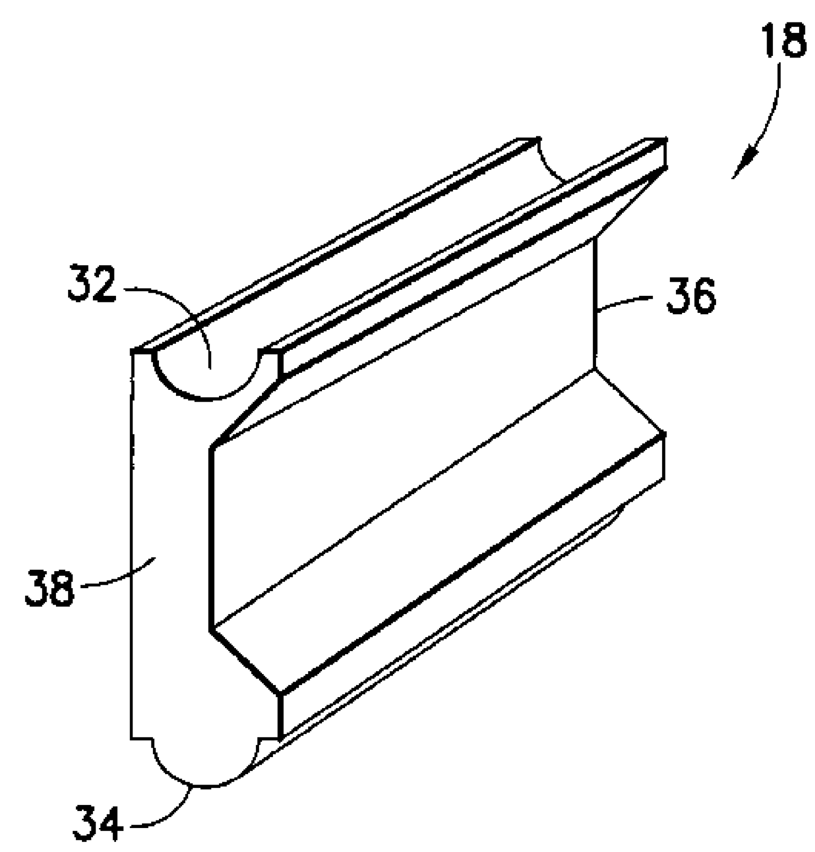
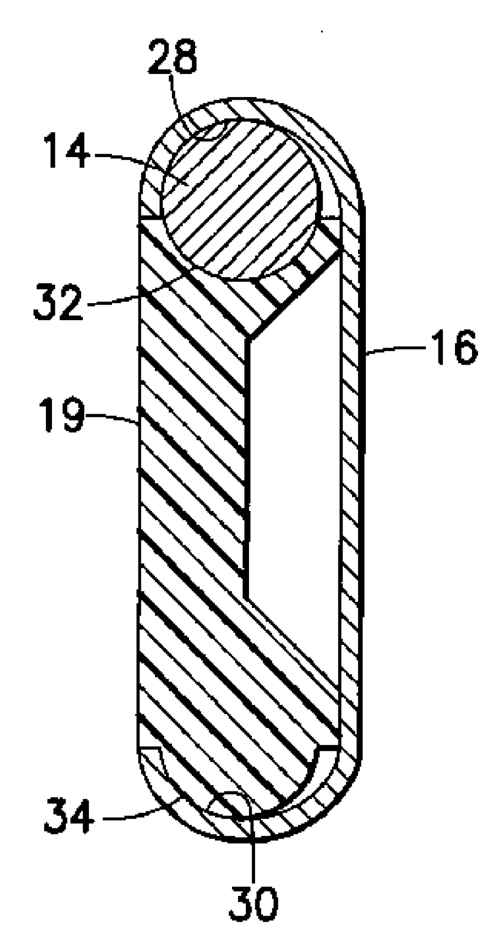
(57) **ABSTRACT**

An electrical conductor splice for connecting at least two electrical conductors. The splice includes a connector shell having a generally elongate open first lateral side; and two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell. Each wedge has a first side with a conductor contact surface and an opposite second side with a shell contact surface. The shell includes a conductor contact section for contacting the conductors. The conductor contact section is adapted to receive two of the conductors into the shell from opposite directions in generally coaxially aligned positions.

35 Claims, 8 Drawing Sheets







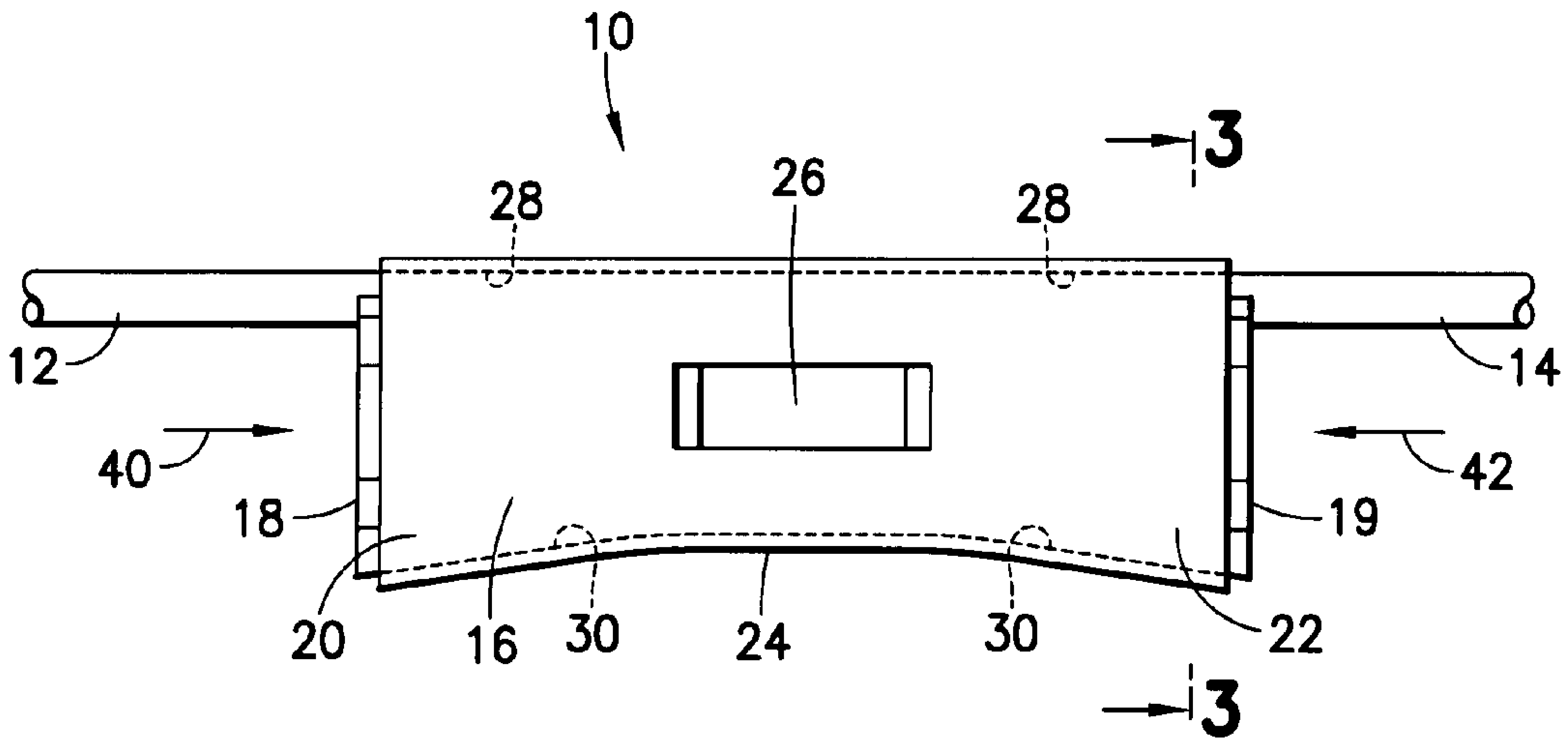


FIG.1

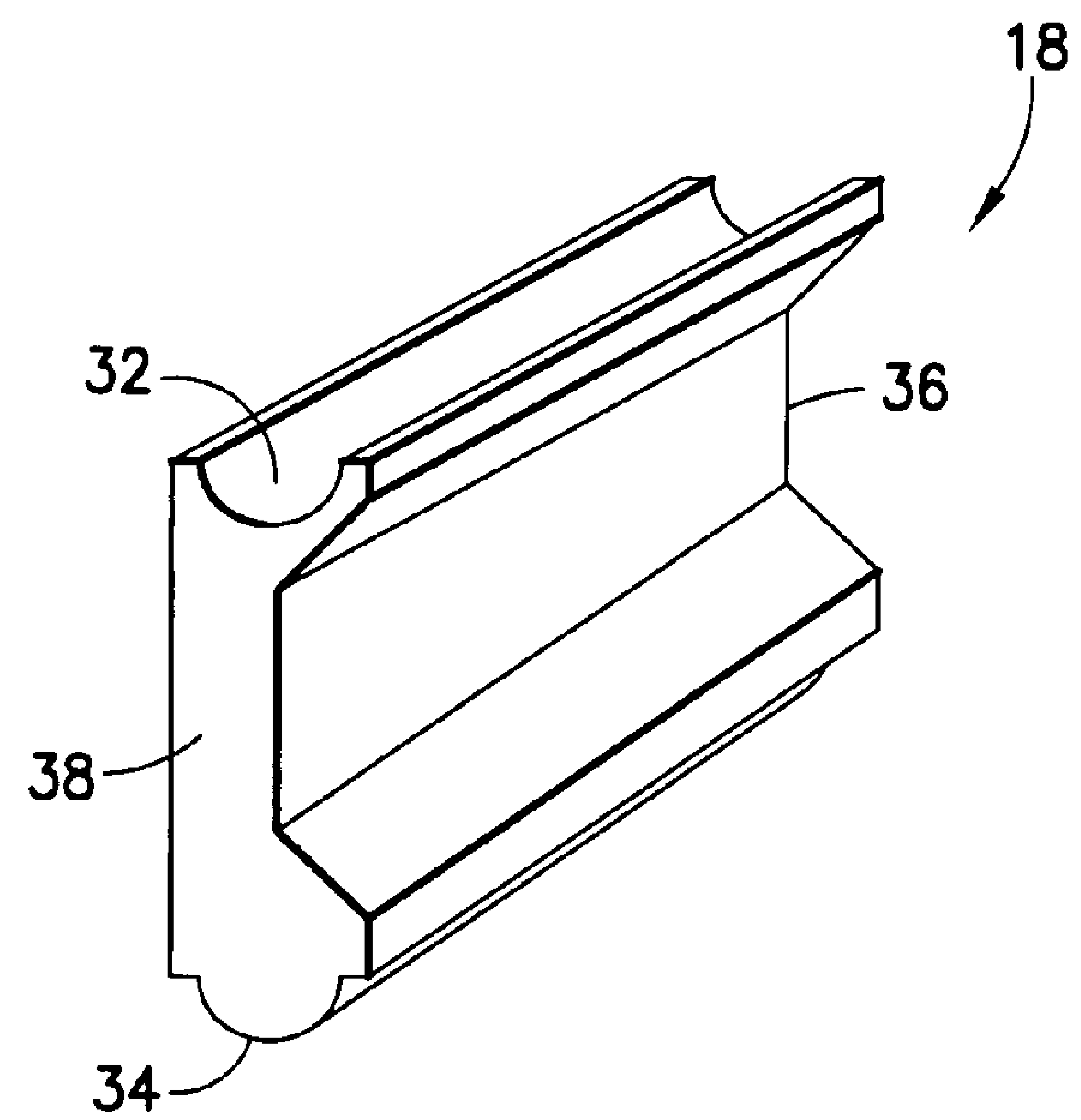


FIG.2

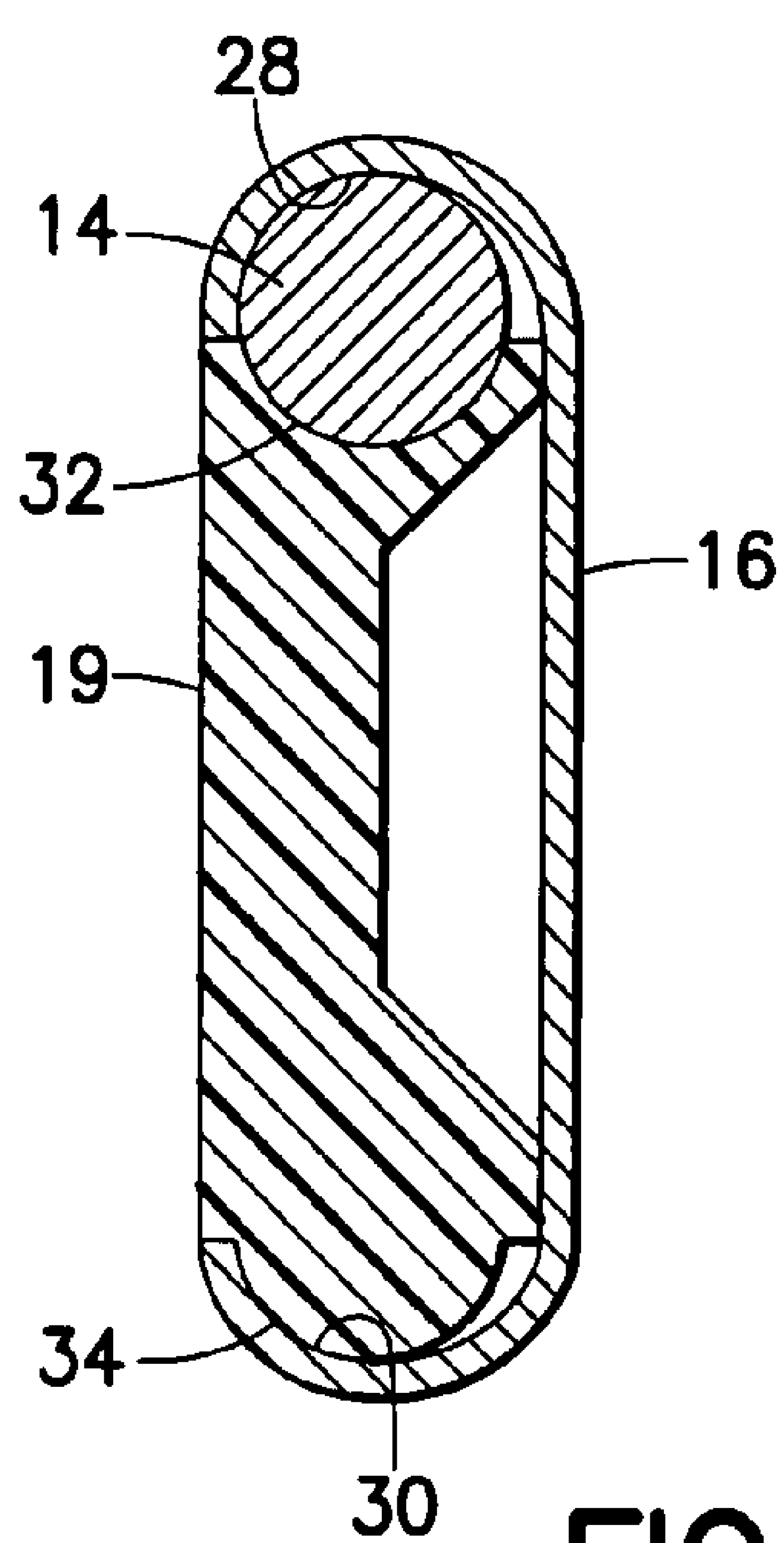


FIG.3

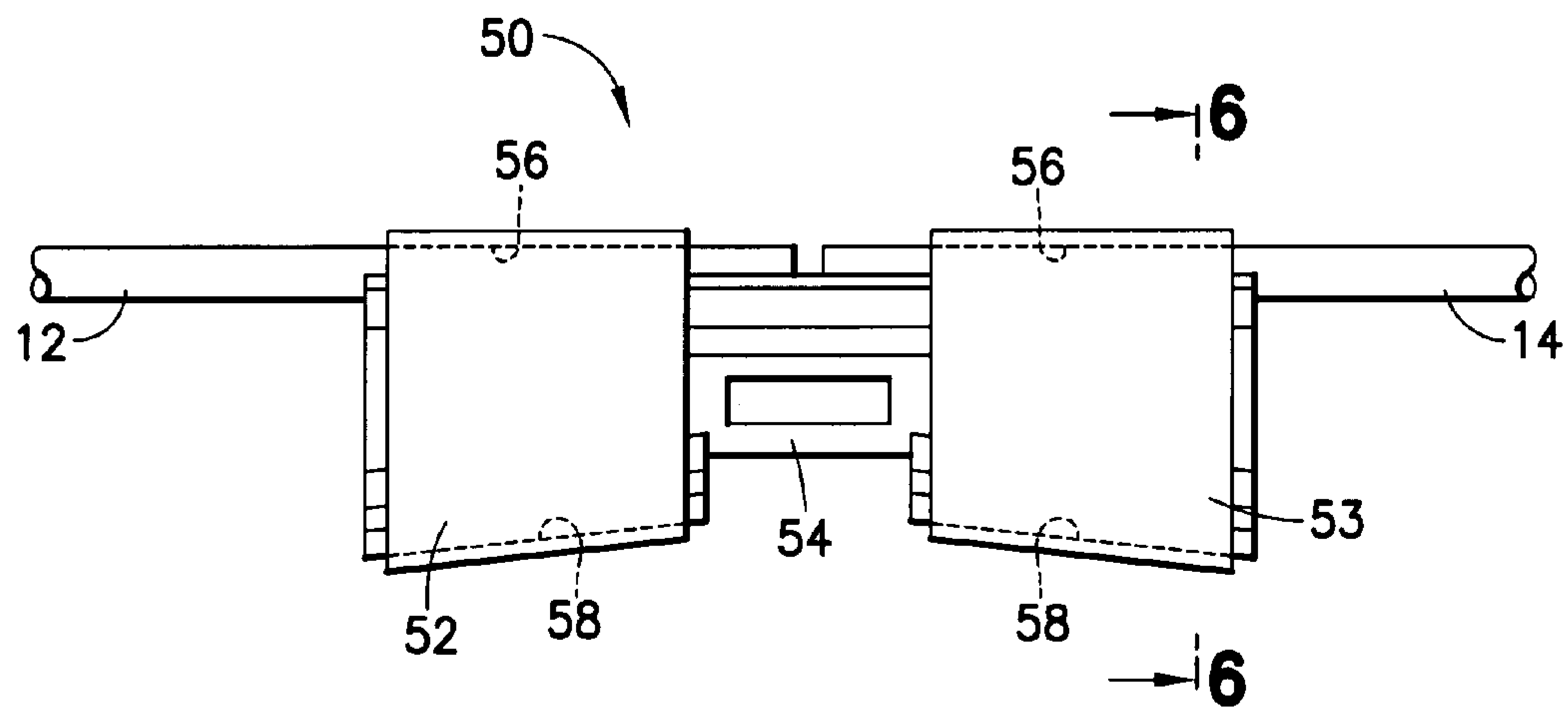


FIG.4

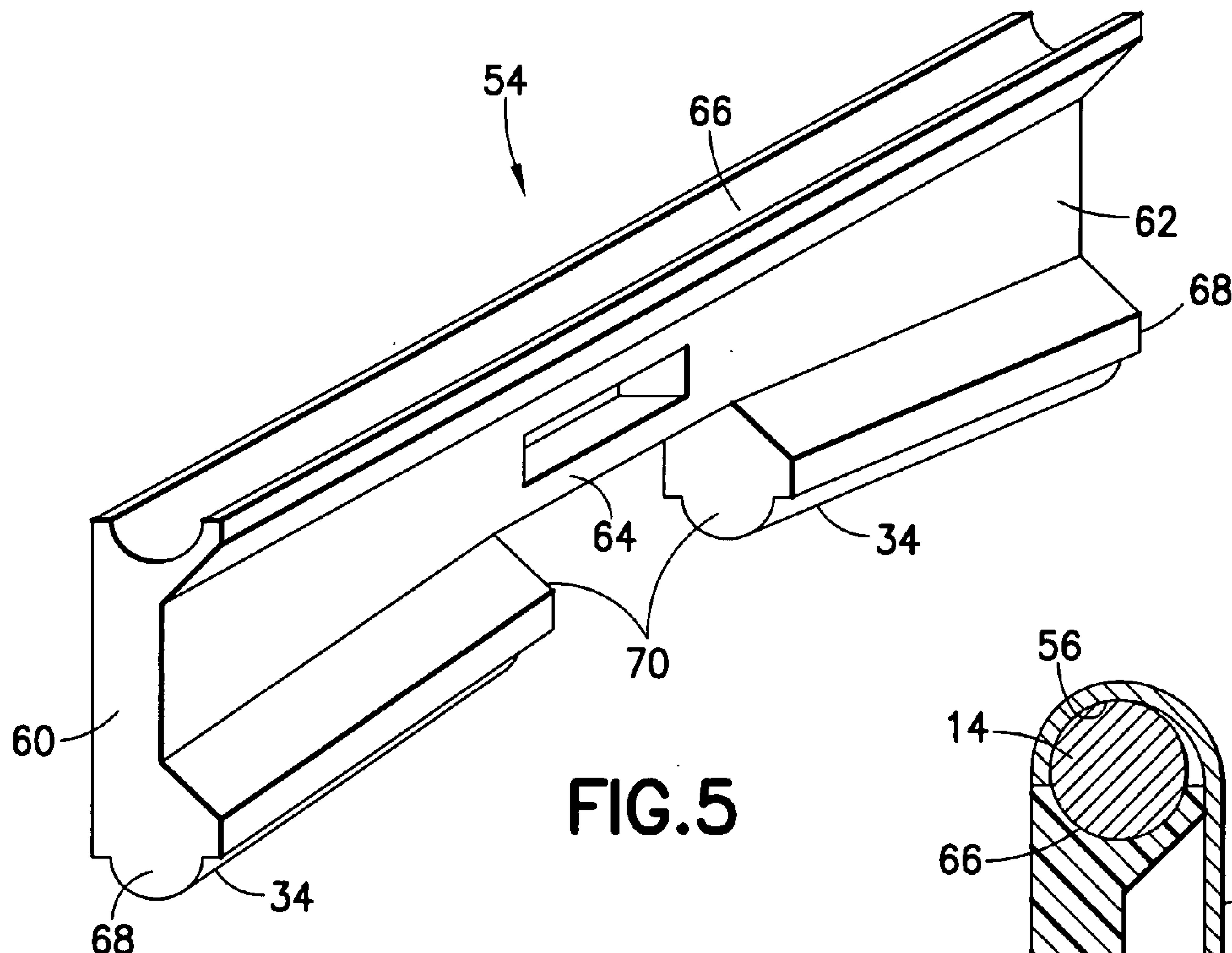


FIG.5

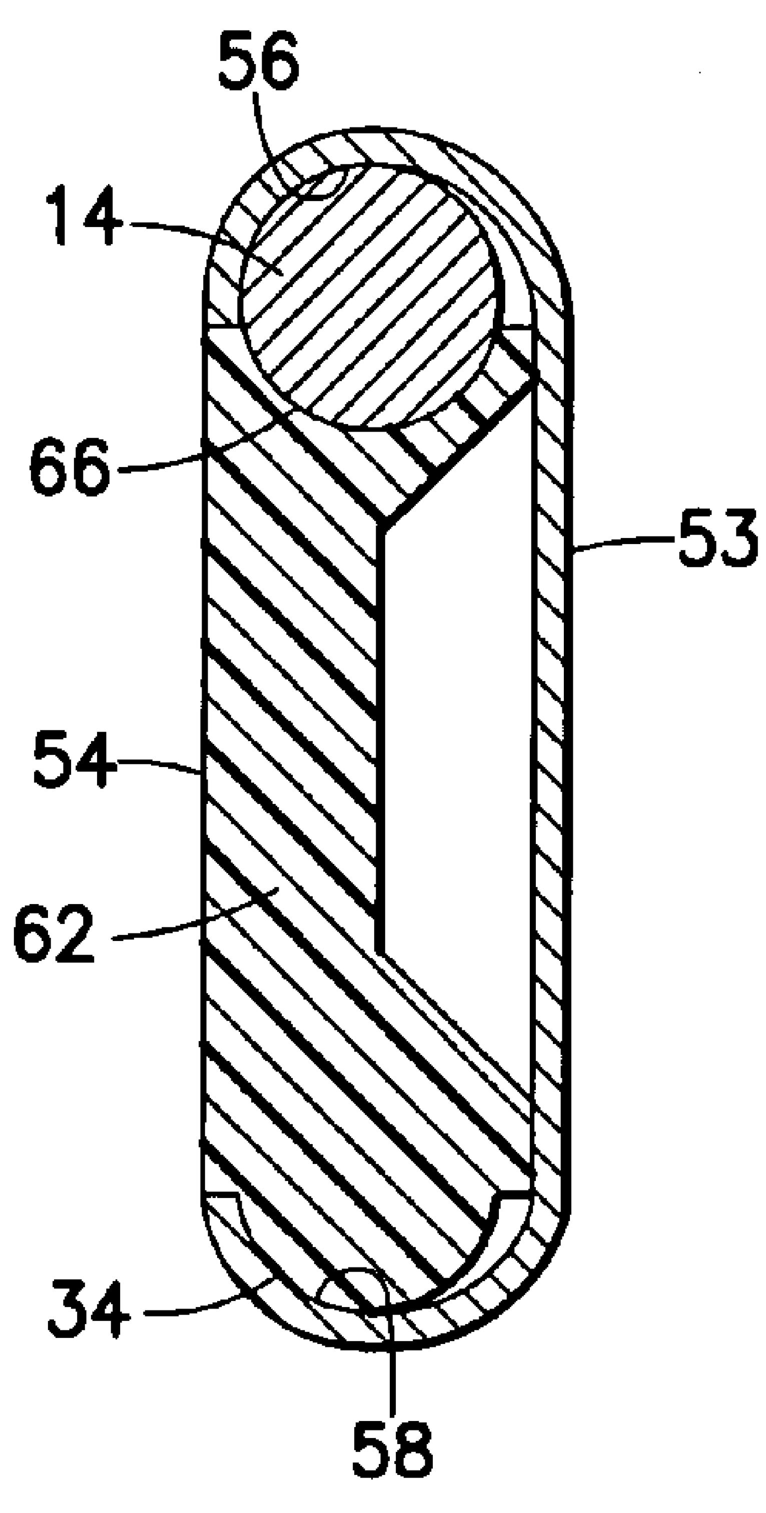


FIG.6

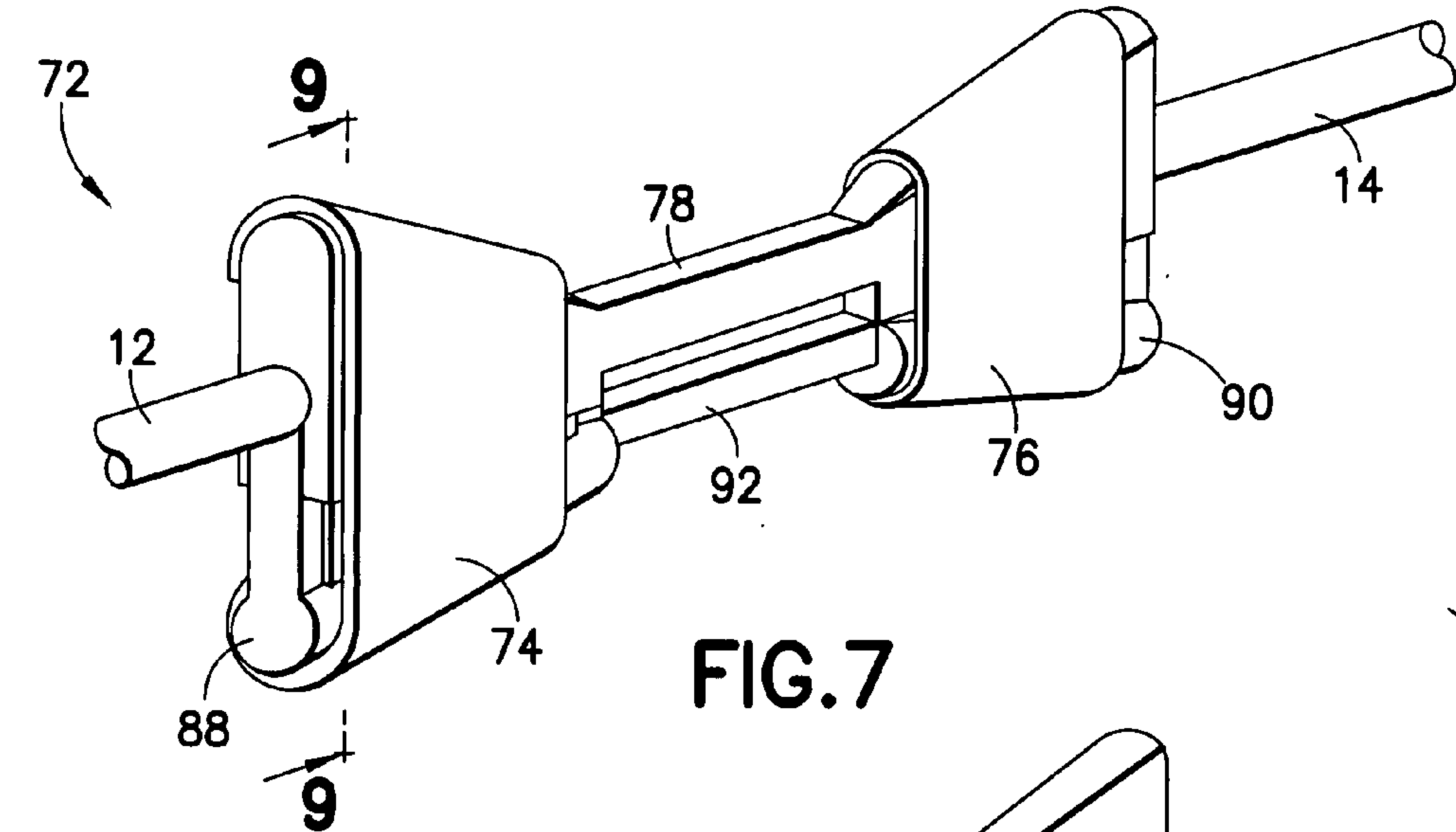


FIG.7

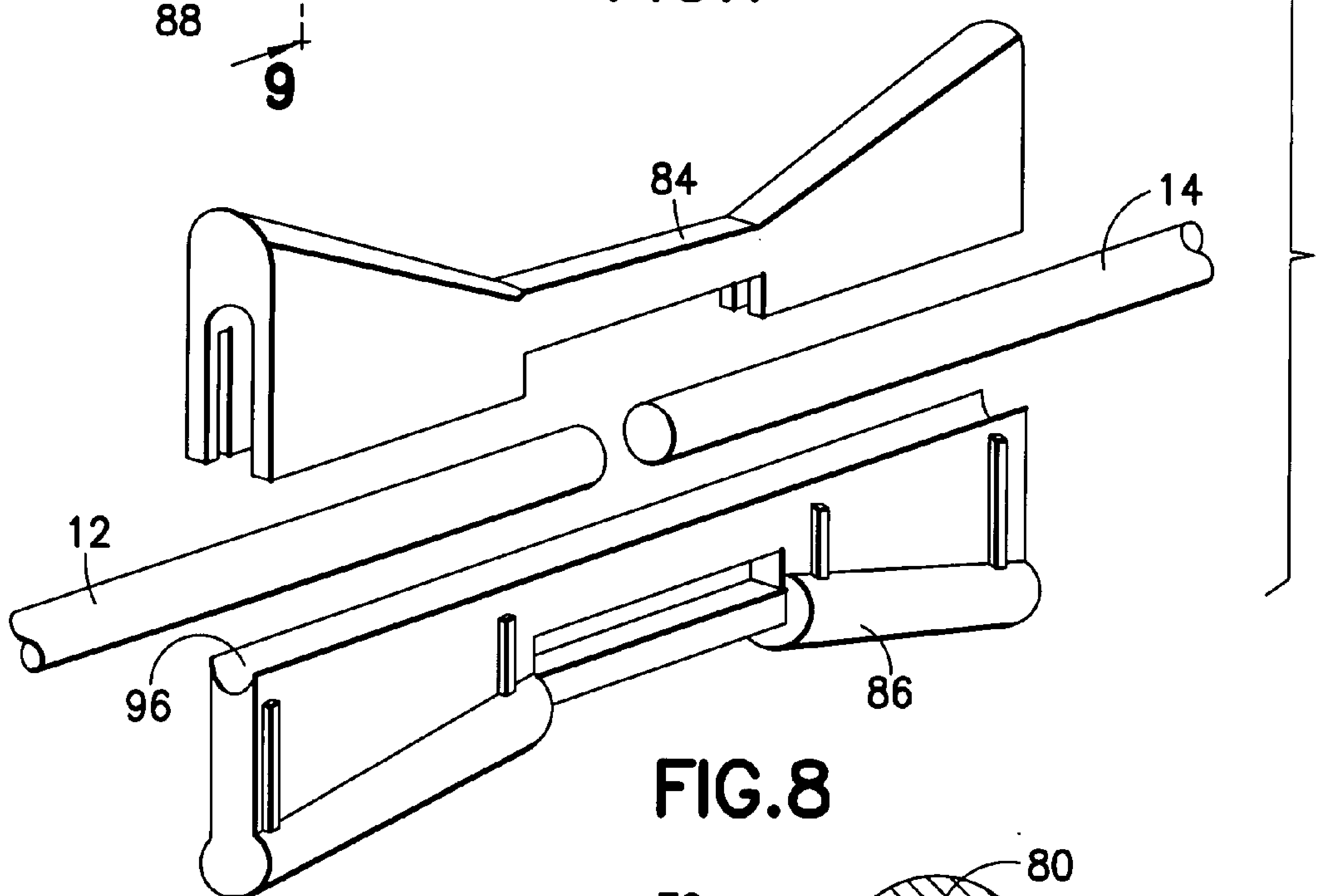


FIG.8

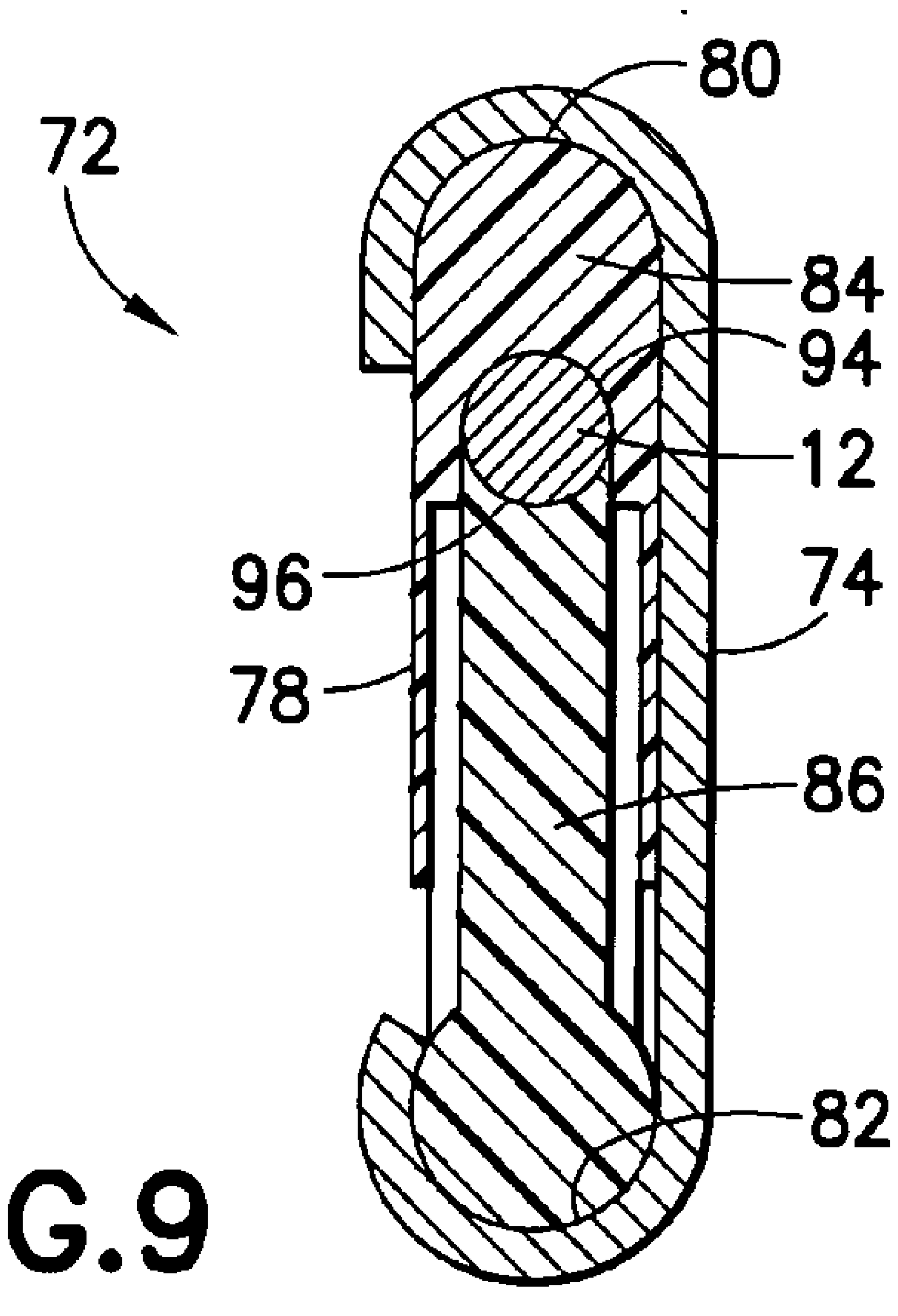


FIG.9

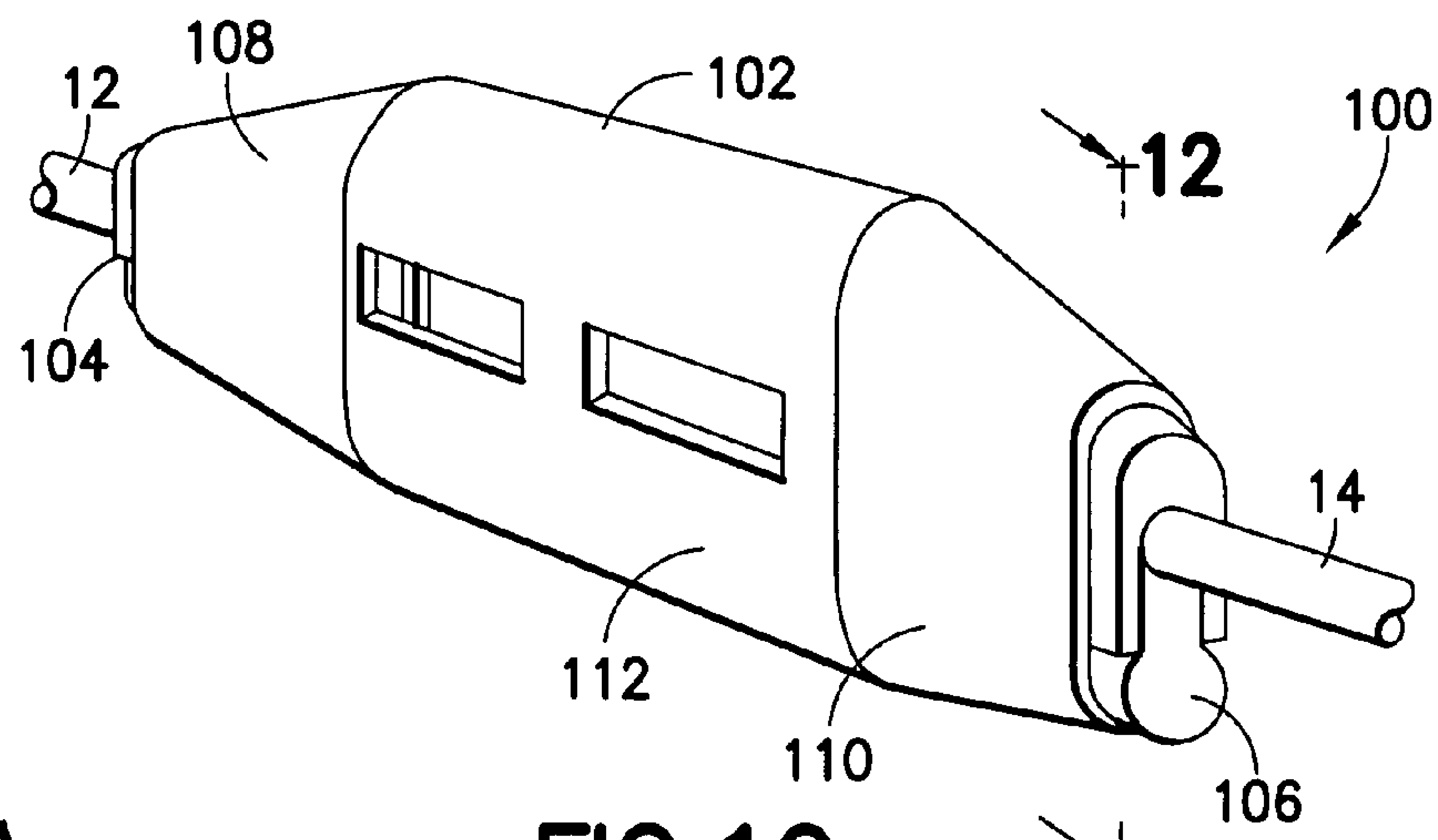


FIG. 10

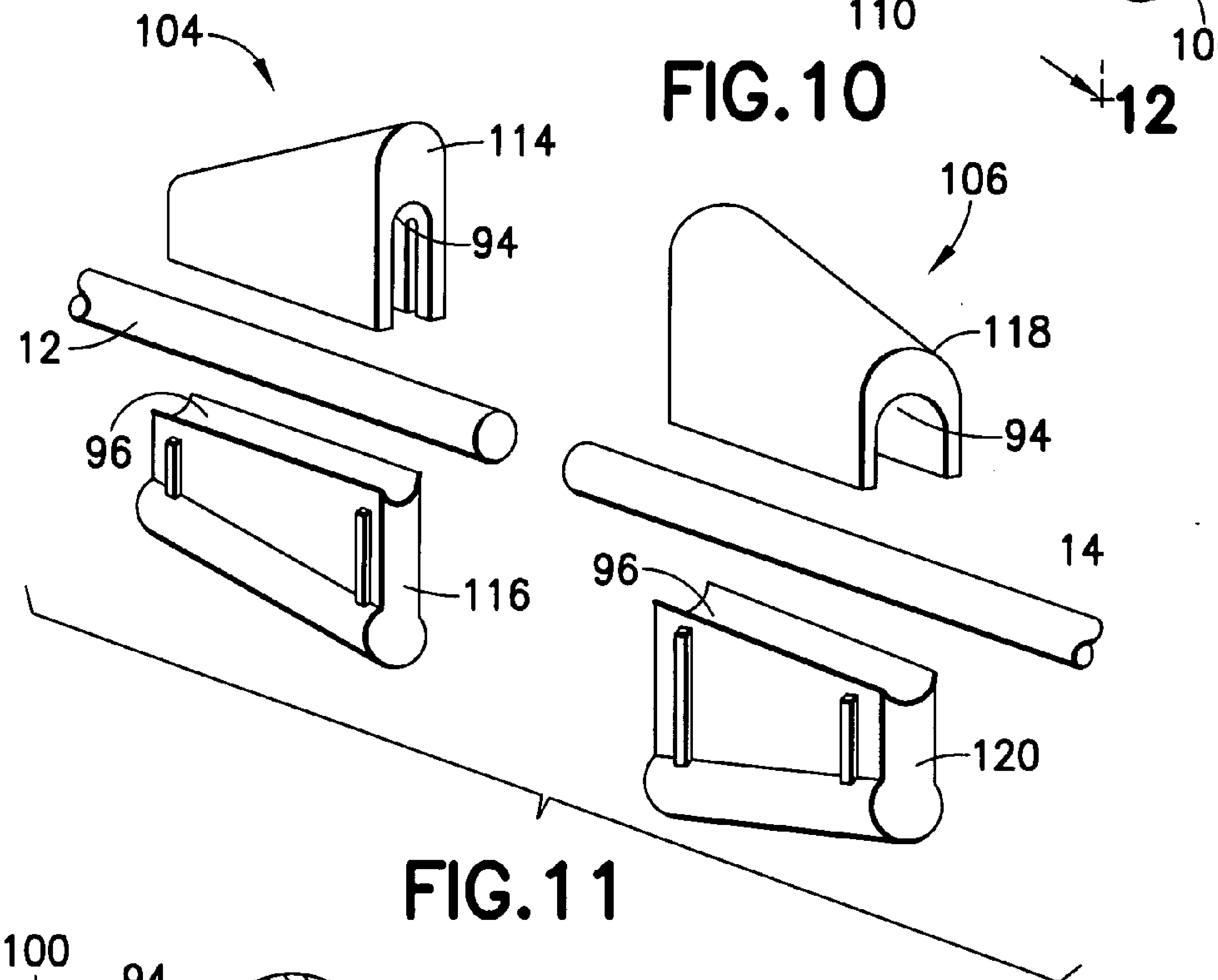


FIG. 11

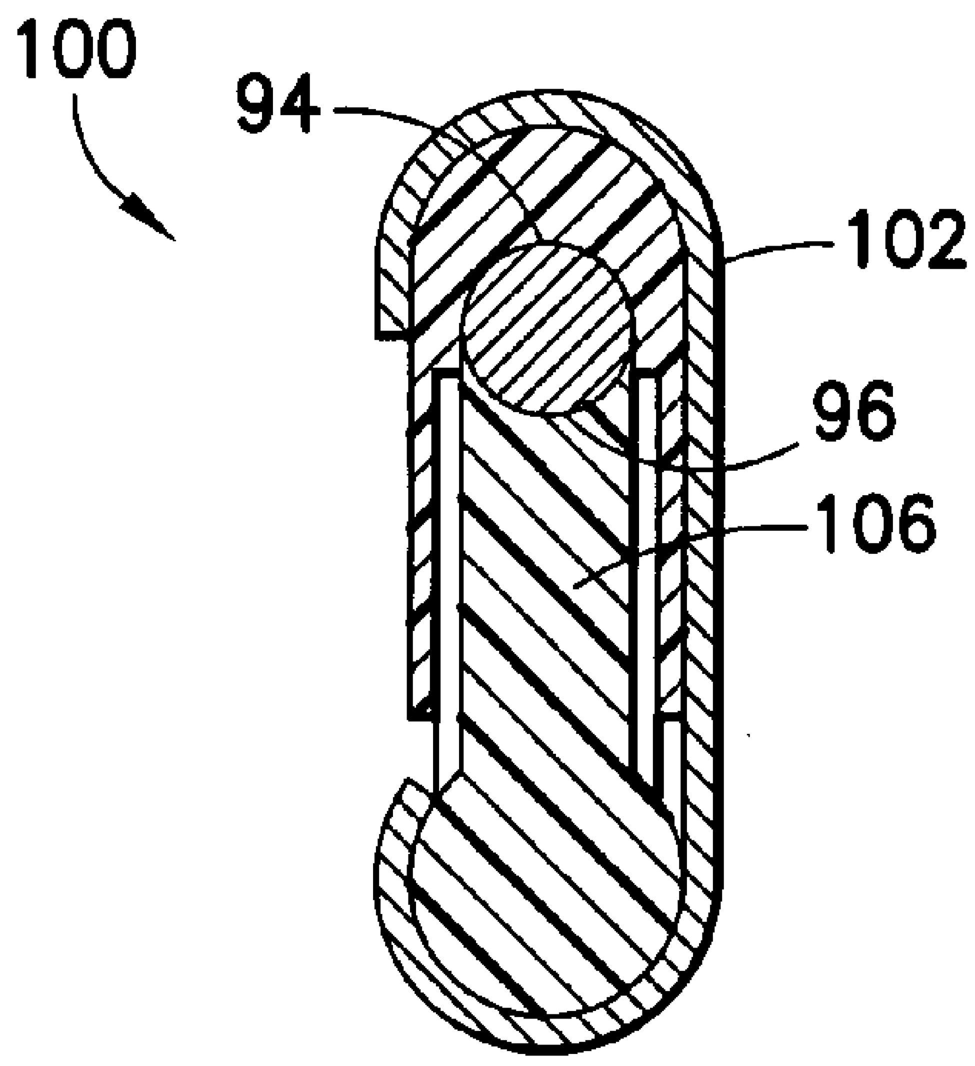


FIG. 12

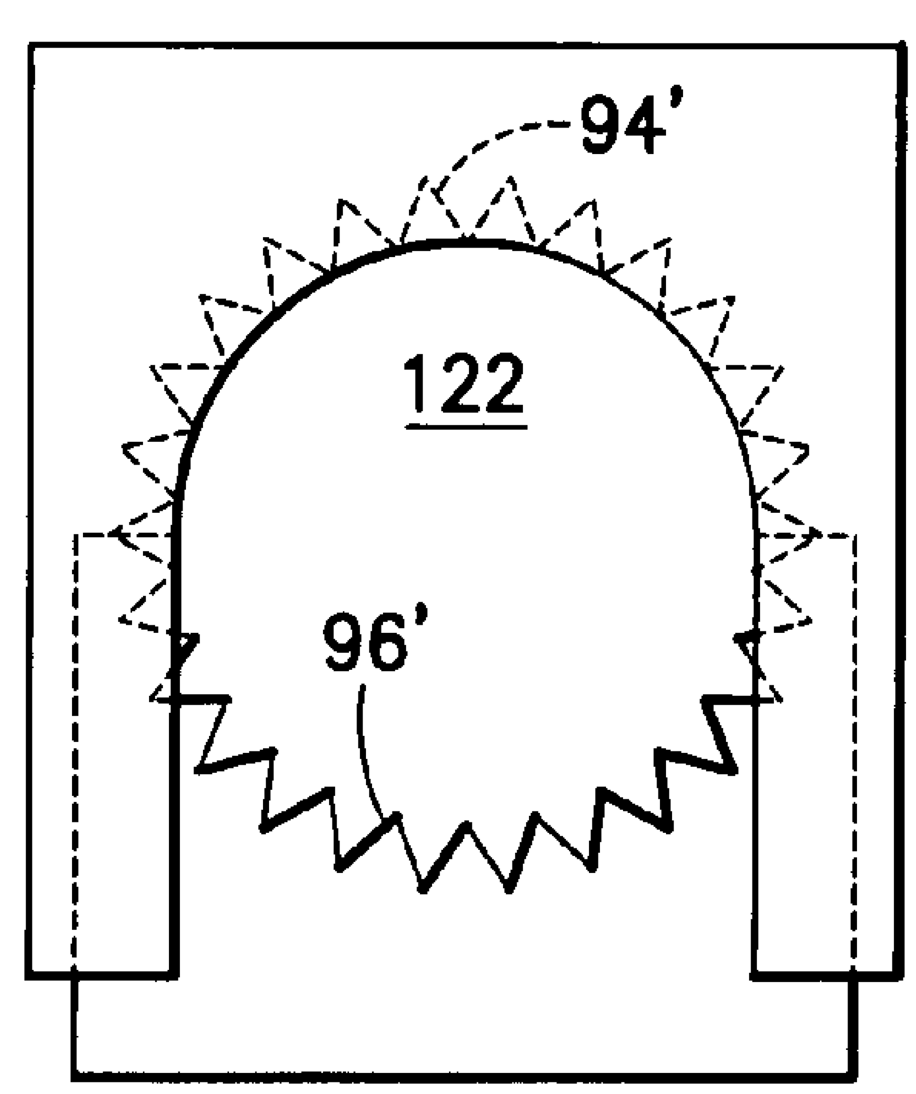


FIG. 13

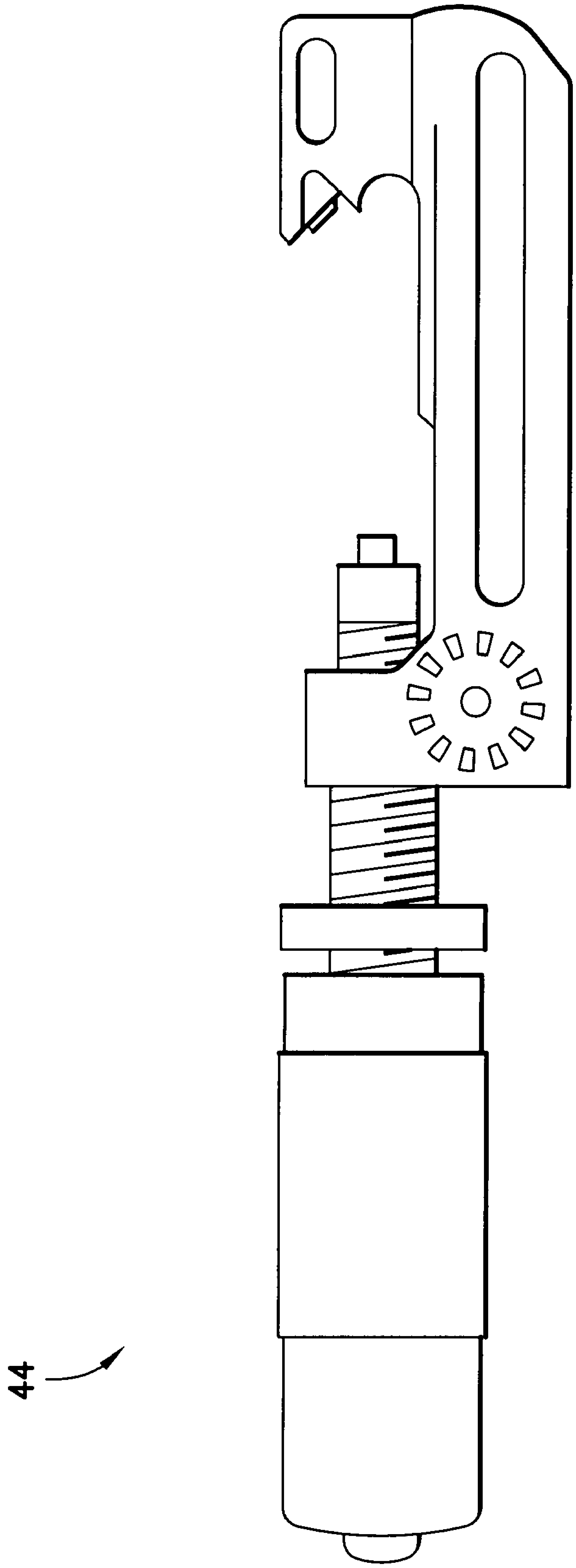


FIG. 14
PRIOR ART

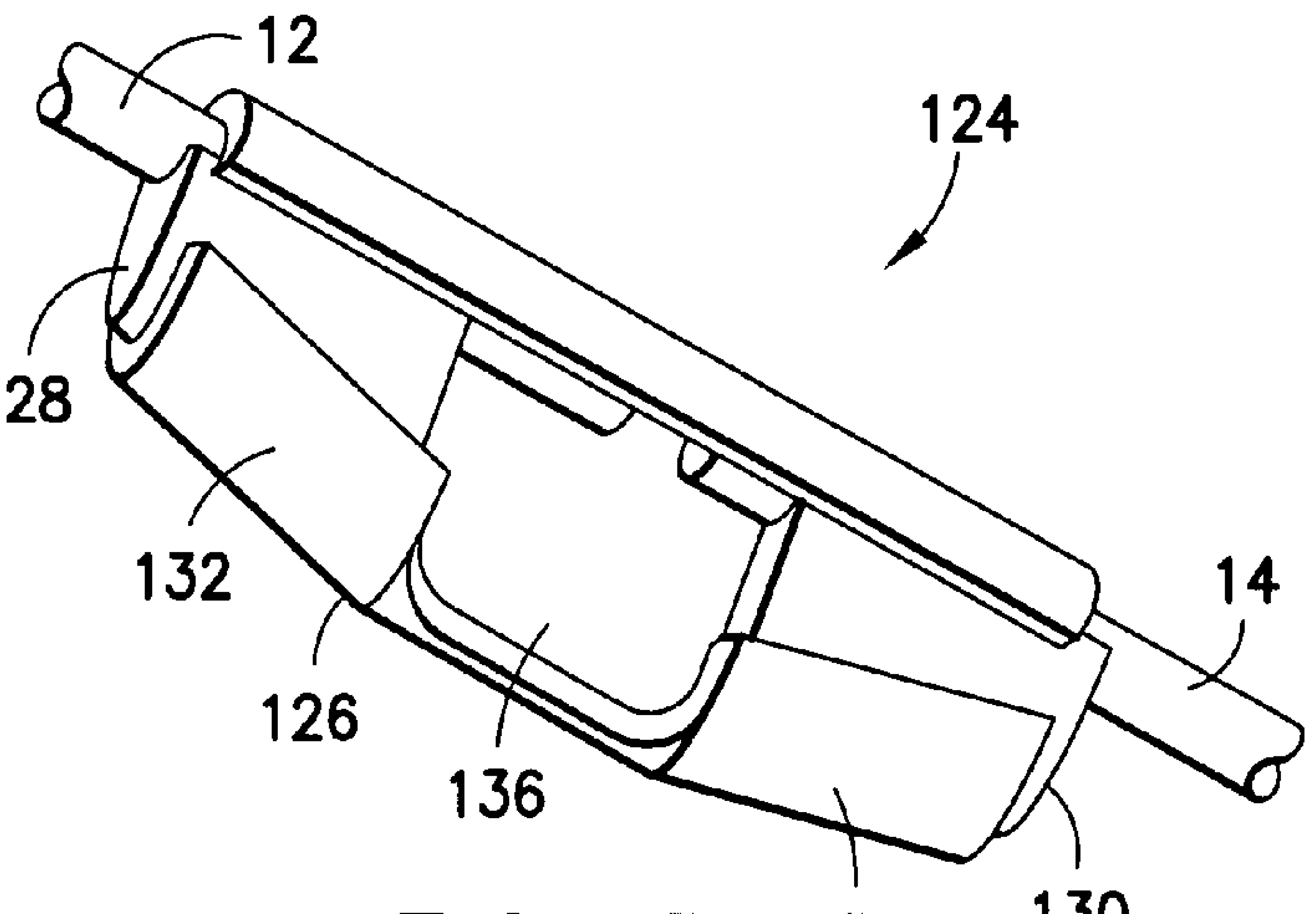


FIG.15

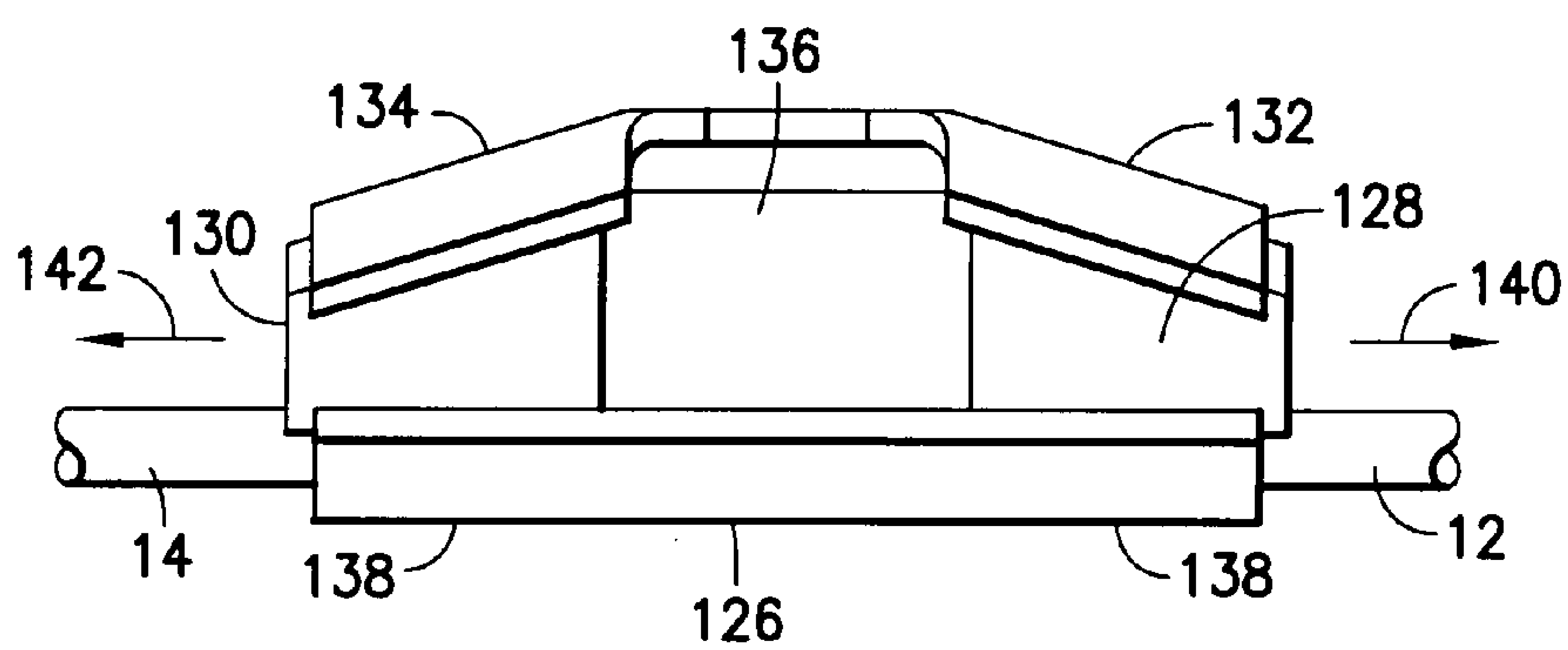


FIG.16

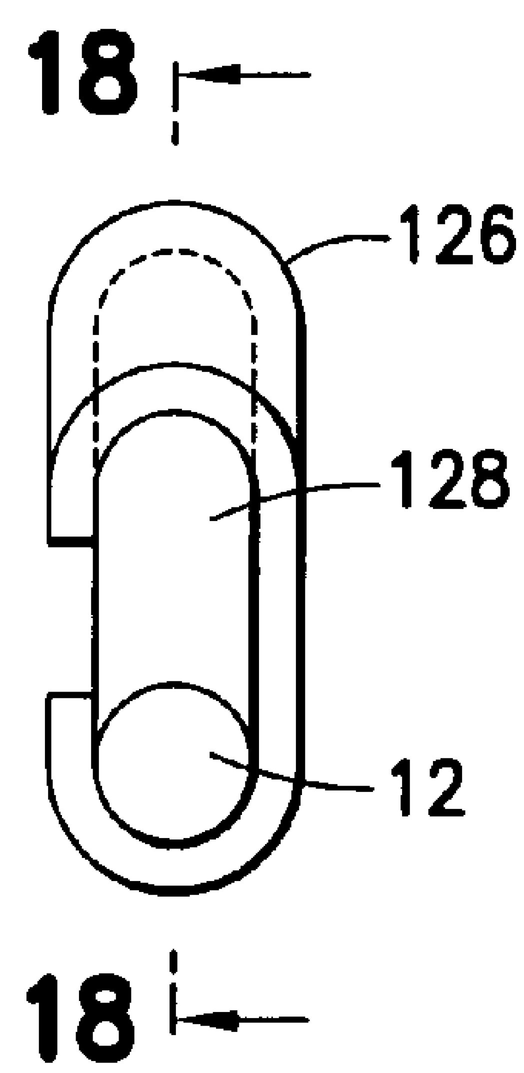


FIG.17

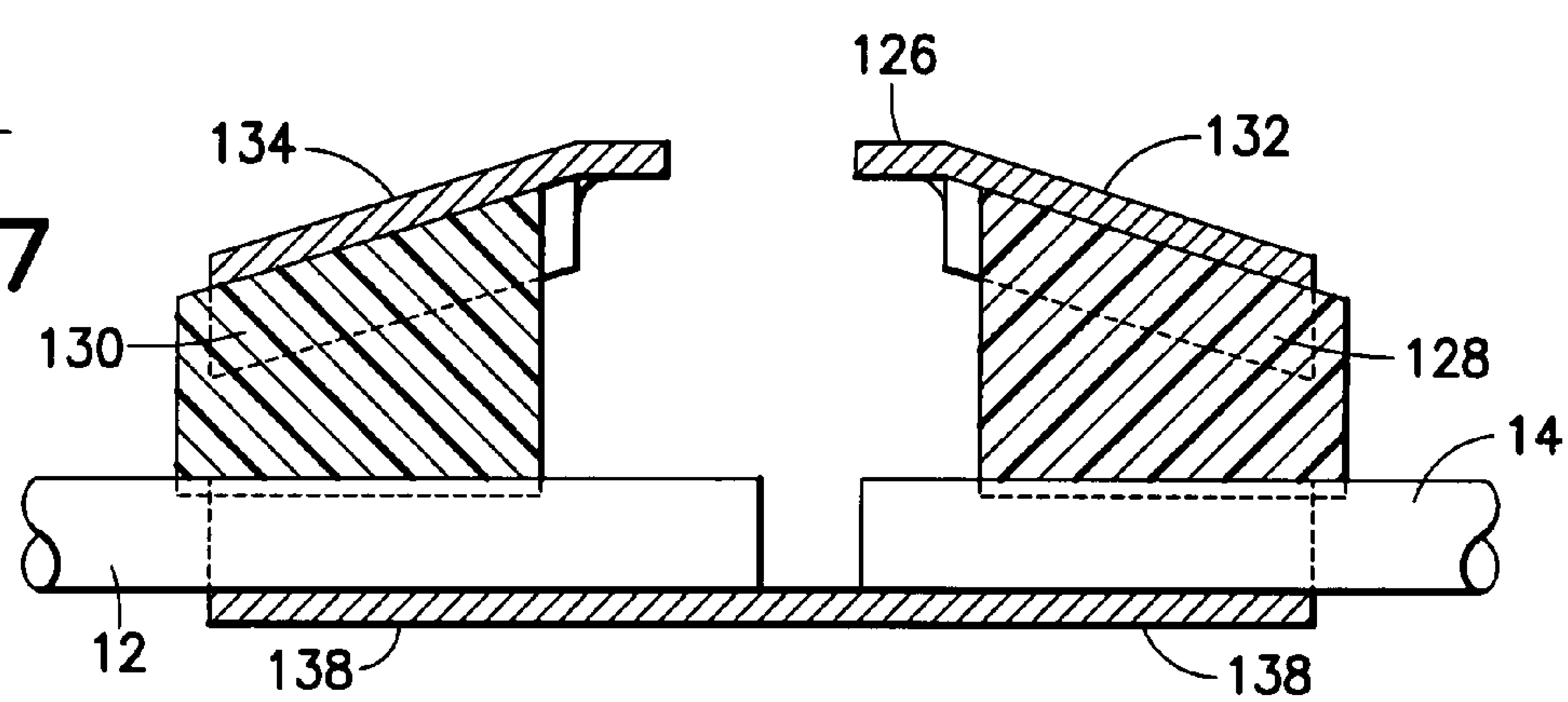


FIG.18

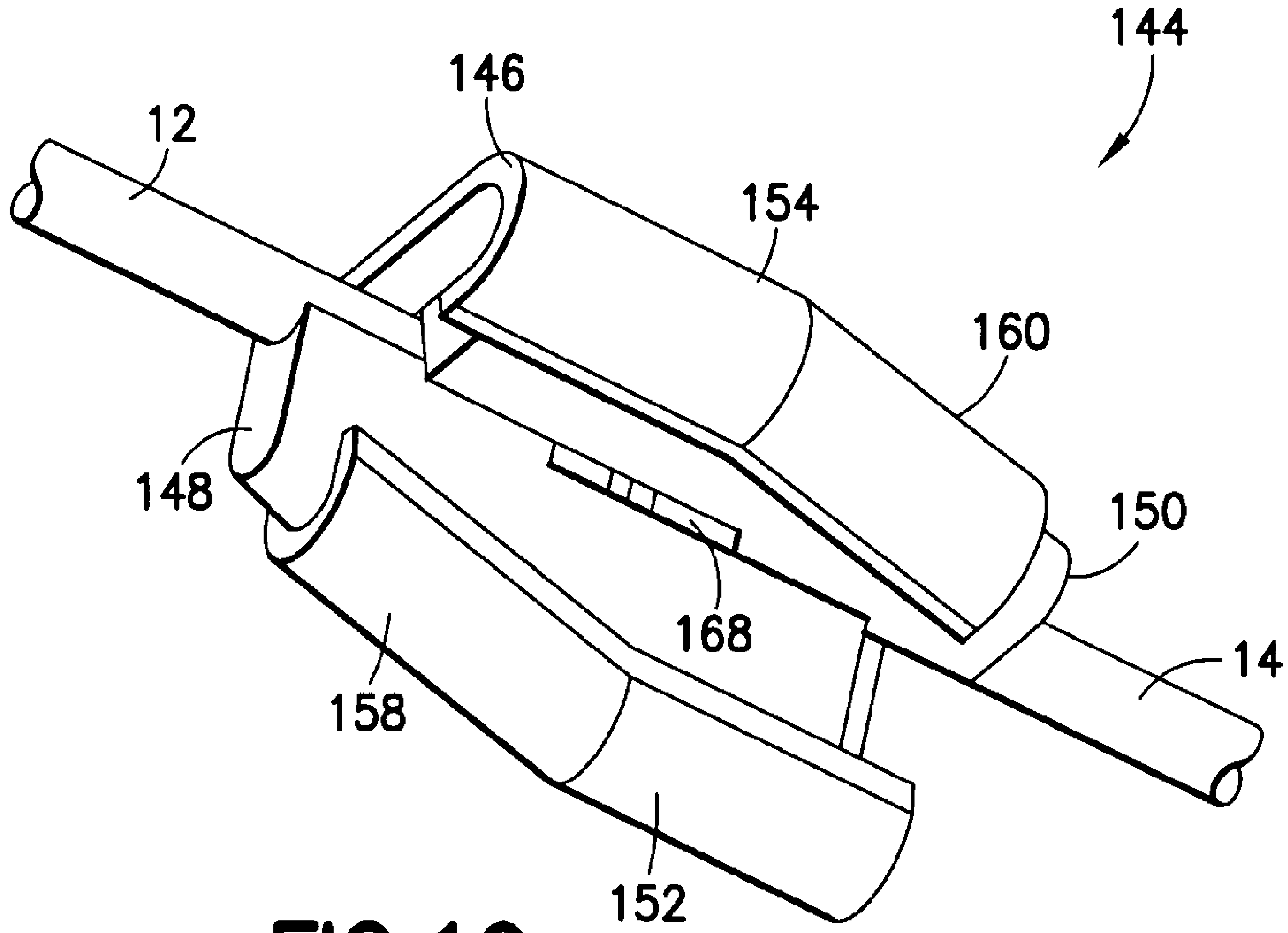


FIG.19

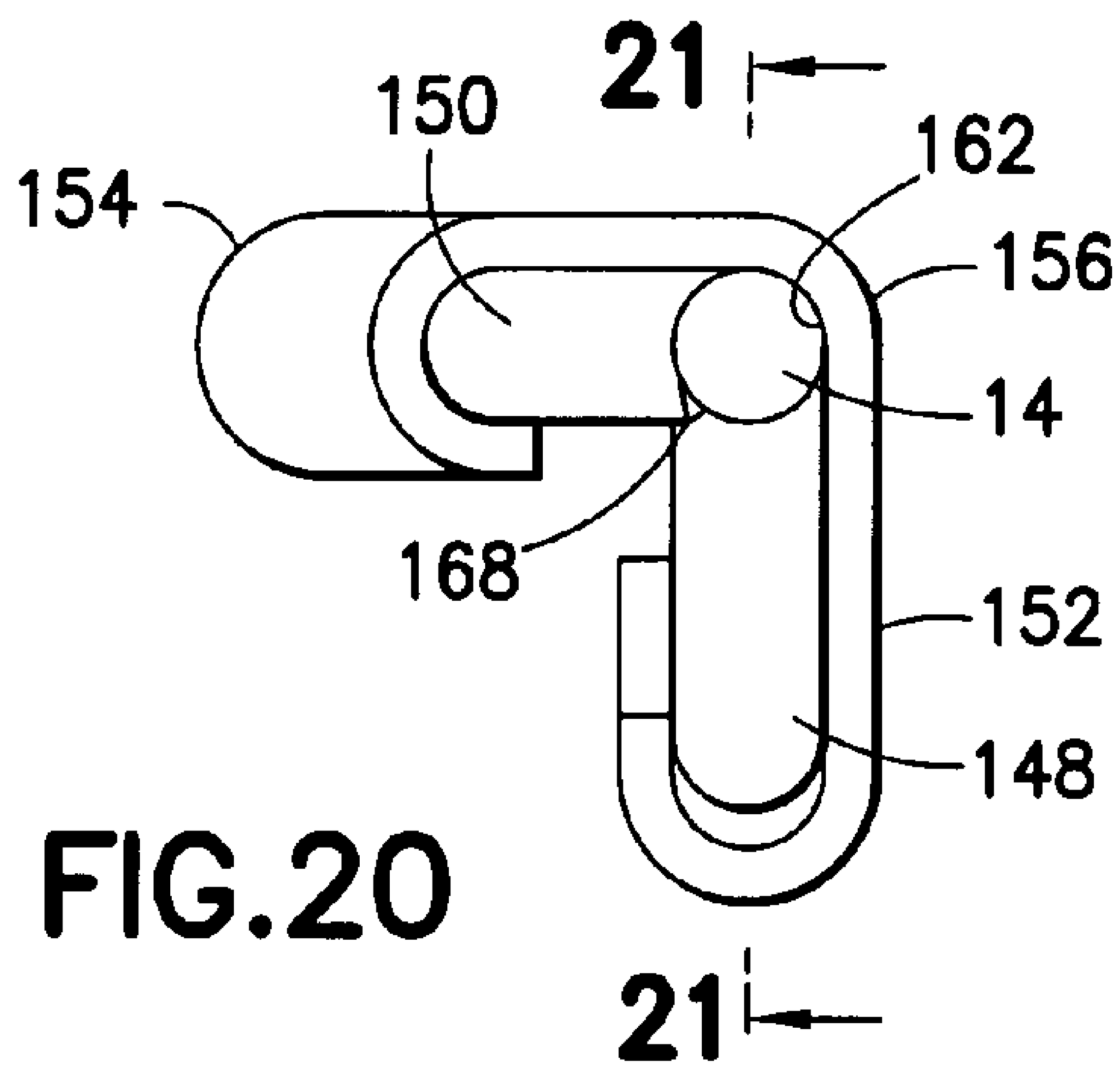


FIG.20

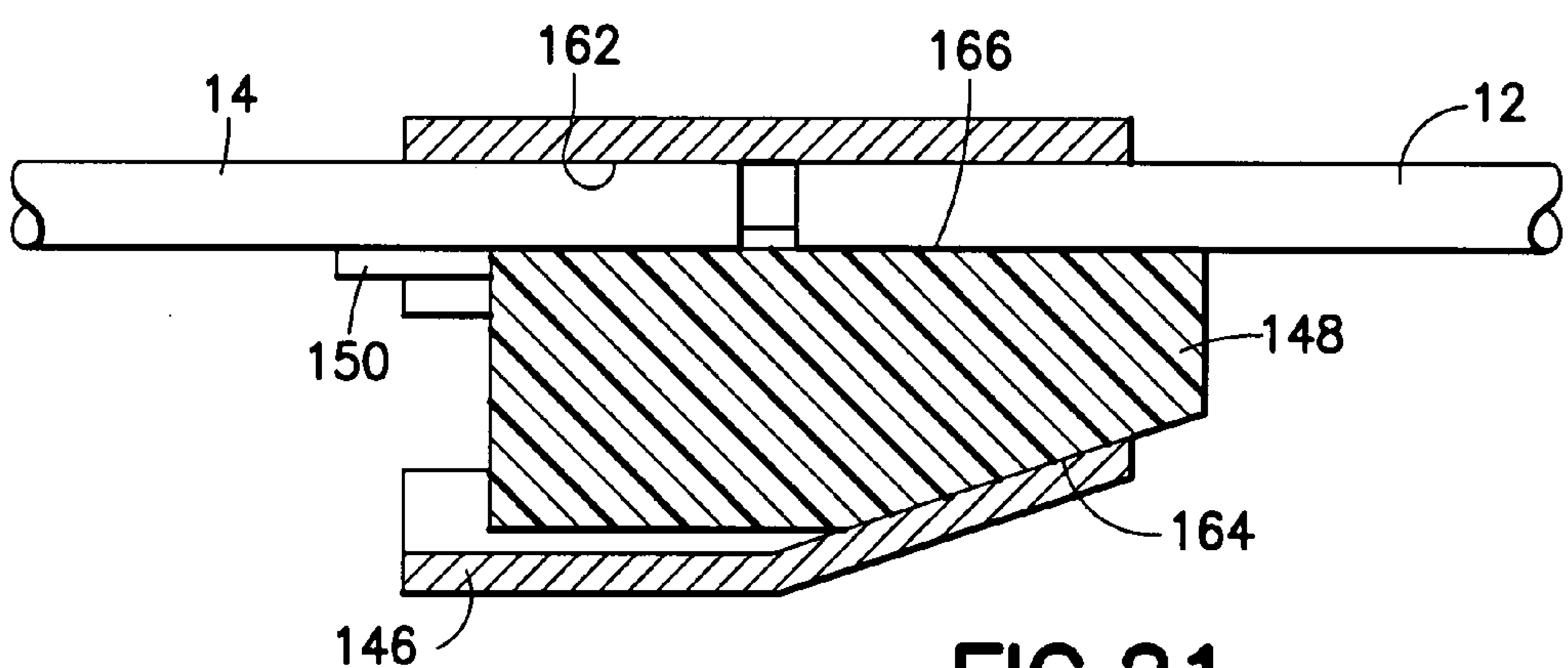


FIG.21

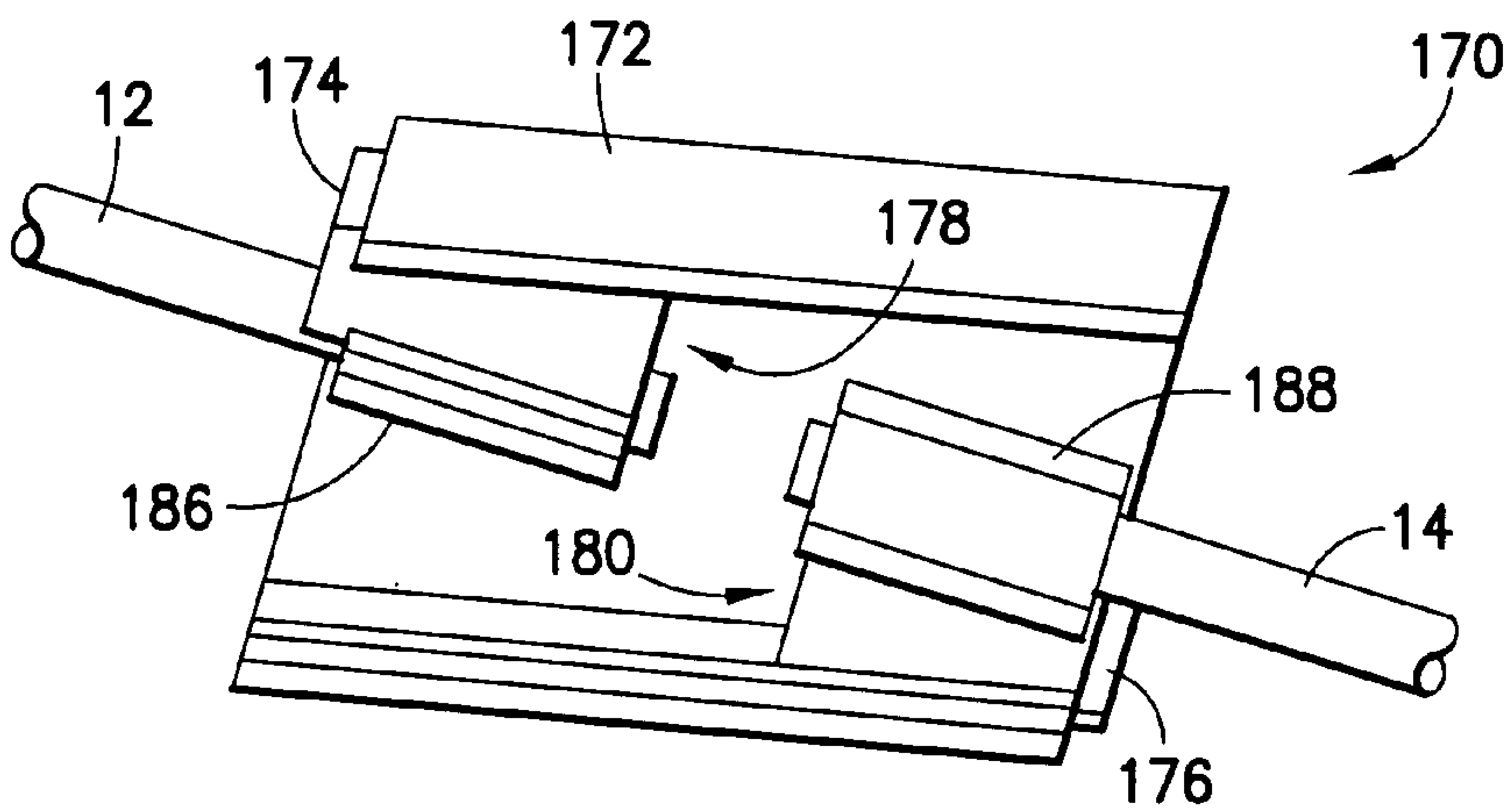


FIG.22

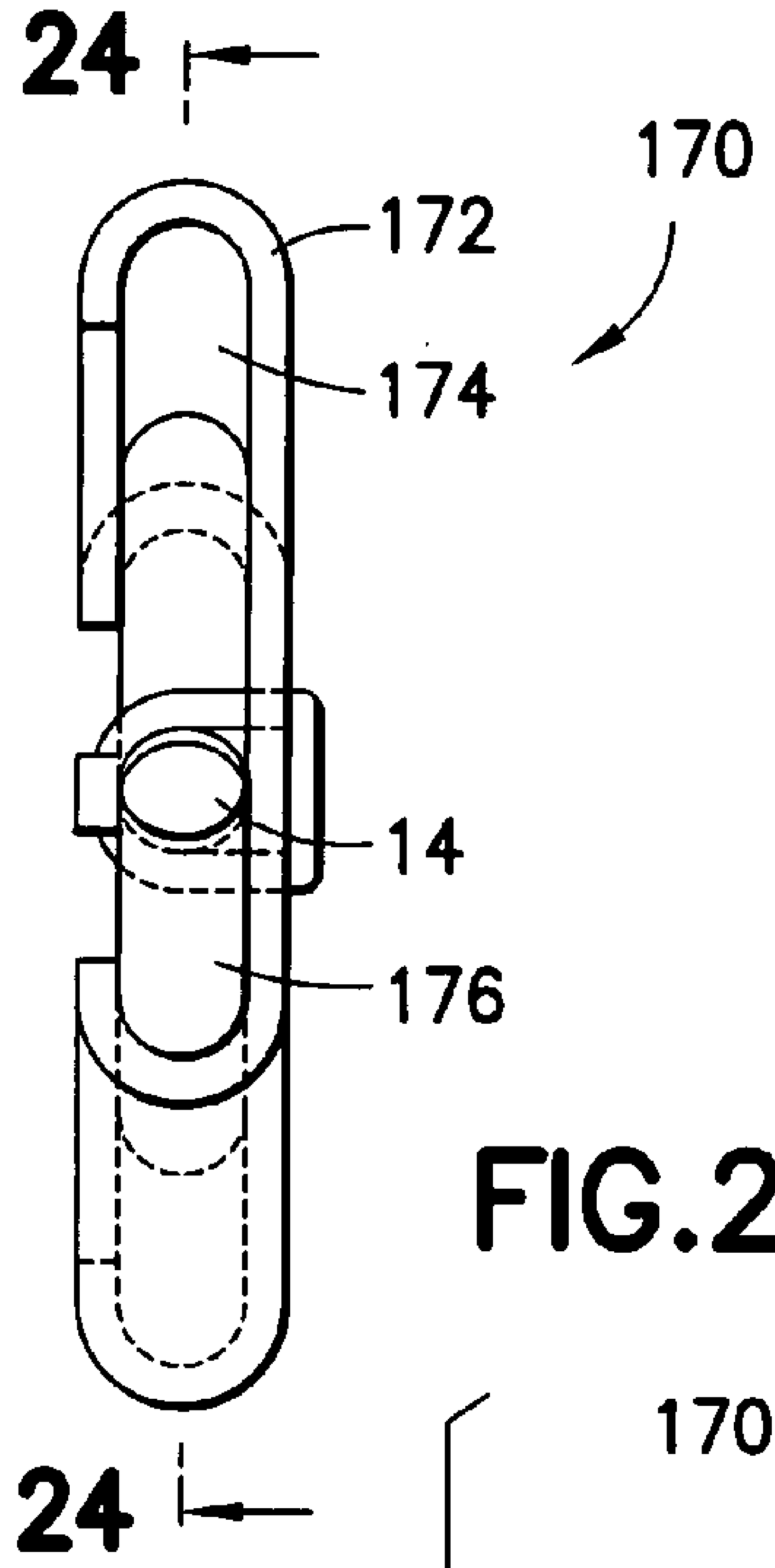


FIG.23

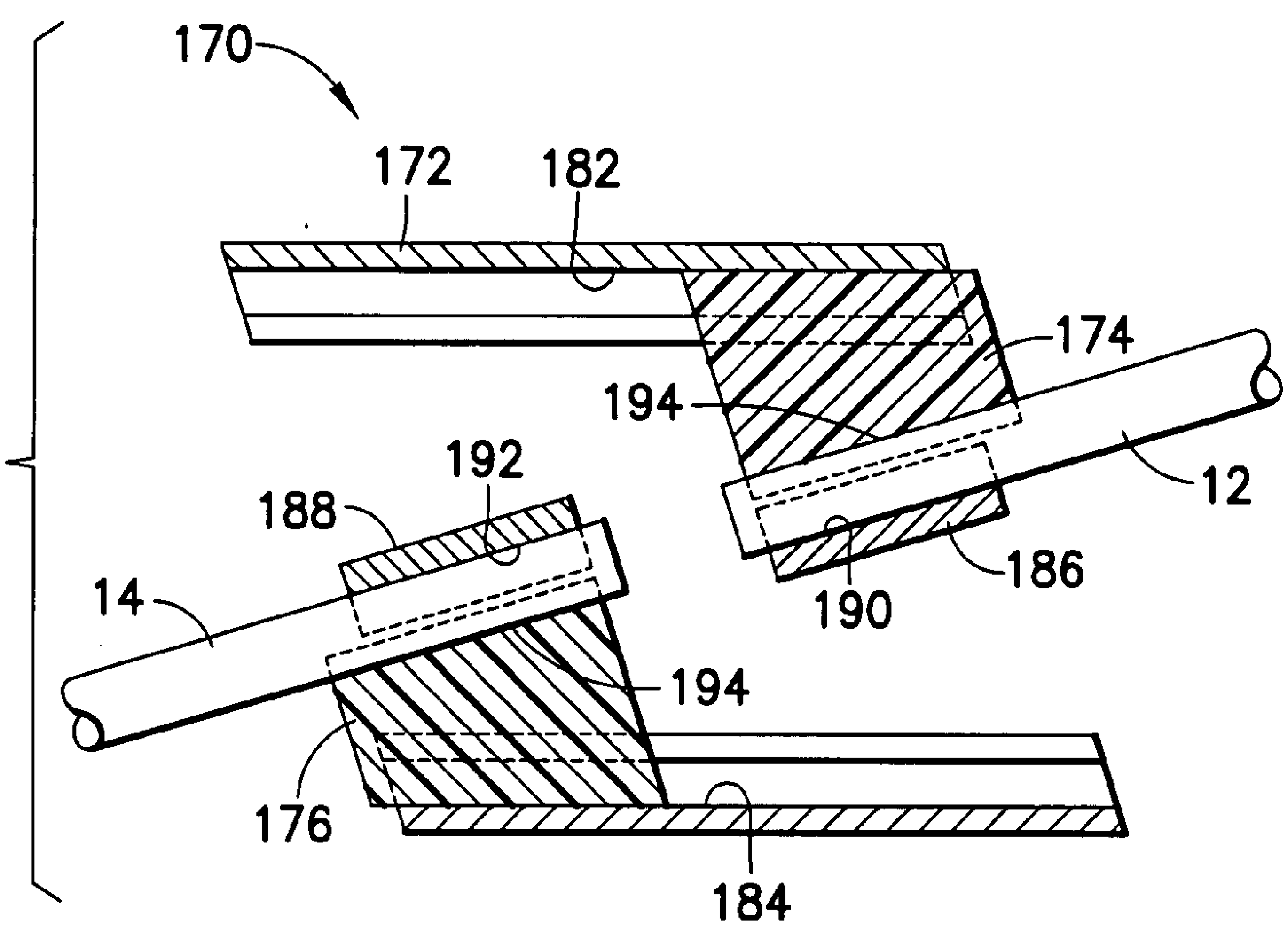


FIG.24

ELECTRICAL CONDUCTOR WEDGE CONNECTOR SPLICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to electrical connectors and, more particularly, to a splice for connecting electrical conductors.

2. Brief Description of Prior Developments

U.S. Pat. No. 6,193,565 discloses a splicing connector having a connector shell with a general H shaped cross section. The splicing connector includes two wedge assemblies that are inserted into the H shaped connector shell for attaching two electrical conductors to each other. Electrical wedge connectors are also well known in the art, such as disclosed in U.S. Pat. No. 5,868,588 which include a tapering cross sectional C shape shell and a wedge. A powder actuated tool, such as a Wejtap™ tool sold by FCI USA, Inc., is used to propel the wedge into the shell to fixedly attach to conductors to each other.

In the early 1990's, an automatic splice was introduced to the electric utility market in the United States. Although initially promoted as a convenient, temporary connection to speed outage restoration, it's easy, tool-free installation quickly made it a favorite among linemen. In rather short order, automatic splices were soon being employed as permanent installations in almost every utility in the United States. However, 10 years later, automatic splices are failing at an alarming rate and most major utilities are desperately seeking a reliable, cost-efficient replacement. However, despite these failures, most utilities remain unwilling to mandate a return to the time tested (but labor-intensive) process of installing compression high-tension sleeves. As such, an incredibly large and enormously profitable, untapped market awaits the first manufacturer to produce a high-tension splice that provides reliability and ease of installation at an affordable price.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, an electrical conductor splice is provided for connecting at least two electrical conductors. The splice includes a connector shell having a generally elongate open first lateral side; and two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell. Each wedge has a first side with a conductor contact surface and an opposite second side with a shell contact surface. The shell includes a conductor contact section for contacting the conductors. The conductor contact section is adapted to receive two of the conductors into the shell from opposite directions in generally coaxially aligned positions.

In accordance with another aspect of the present invention, an electrical conductor splice connector shell is provided comprising a first wedge receiving end section having a general wedge shaped profile; and a second wedge receiving end section having a general wedge shaped profile. The first and second end sections are located at opposite longitudinal ends of the shell and have their wedge shaped profiles orientated in general reverse directions.

In accordance with another aspect of the present invention, an electrical wedge connector splice wedge is provided comprising a first end section having a general wedge shaped profile with a first conductor contact surface on a first side of the wedge; and a second end section having a general wedge shaped profile with a second conductor contact surface on the first side of the wedge. The first and second end sections are located at opposite longitudinal ends of the wedge. Their wedge shaped profiles are orientated in general reverse directions.

In accordance with another aspect of the present invention, an electrical wedge connector splice wedge is provided comprising a first member having a first side and a second opposite side, the first side comprising a first electrical wedge connector splice shell contact surface, the second opposite side comprising a slot extending into the second opposite side, the slot having a first conductor contact surface therein; and a second member movably connected to the first member. The second member extends into the slot. The second member comprises a first side and an opposite second side. The first side of the second member comprising a second electrical wedge connector splice shell contact surface located in the slot. The second opposite side of the second member comprising a second conductor contact surface. The first and second conductor contact surfaces are located opposing each other.

In accordance with one method of the present invention, a method of connecting two electrical conductors s provided comprising steps of attaching a first electrical wedge connector splice wedge to a first conductor; attaching a second electrical wedge connector splice wedge to a second conductor; inserting the first and second splice wedges into an electrical wedge connector splice shell; and moving the first and second splice wedges in opposite directions, the step of moving comprising a powder actuated tool being fired to wedge the splice wedges into fixed stationary positions at respective opposite ends of the splice shell.

In accordance with another method of the present invention, a method of connecting the two electrical conductors is provided comprising steps of attaching an electrical wedge connector splice wedge to the two conductors, the conductors extending out of opposite respective ends of the splice wedge; connecting two electrical wedge connector shells to opposite respective ends of the splice wedge; and moving the two shells relative with the wedge to wedge the opposite respective ends of the wedge in respective ones of the shells.

In accordance with another aspect of the present invention, an electrical conductor splice for connecting at least two electrical conductors is provided comprising a connector shell; and two wedges adapted to be located in the shell at opposite ends of the shell. Each wedge has a first side with a conductor contact surface and an opposite second side with a shell contact surface. The shell comprises at least one conductor contact section for contacting the conductors. The at least one conductor contact section is adapted to receive two of the conductors in a generally aligned position at the respective opposite ends of the shell.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and other features of the present invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

FIG. **1** is a side view of a splice connector incorporating features of the present invention;

FIG. **2** is a perspective view of one of the wedges used in the splice connector shown in FIG. **2**;

FIG. **3** is a cross sectional view of the splice connector shown in FIG. **1** taken along line **3**—**3**;

FIG. **4** is a side view of an alternate embodiment of a splice connector incorporating features of the present invention;

FIG. **5** is a perspective view of the wedge used in the splice connector shown in FIG. **4**;

FIG. **6** is a cross sectional view of the splice connector shown in FIG. **4** taken along line **6**—**6**;

FIG. **7** is a perspective view of an alternate embodiment of the splice connector;

FIG. **8** is an exploded perspective view of the splice connector shown in FIG. **7** without showing the shells;

FIG. **9** is a cross sectional view of the splice connector shown in FIG. **7** taken along line **9**—**9**;

FIG. **10** is a perspective view of an alternate embodiment of the splice connector;

FIG. **11** is an exploded perspective view of the splice connector shown in FIG. **10** without showing the shell;

FIG. **12** is a cross sectional view of the splice connector shown in FIG. **10** taken along line **12**—**12**;

FIG. **13** is an end view showing an alternate embodiment of the present invention;

FIG. **14** is a side view of a prior art installation tool;

FIG. **15** is a perspective view of another alternate embodiment of the present invention;

FIG. **16** is a side view of the splice connector shown in FIG. **15**;

FIG. **17** is an end view of the splice connector shown in FIGS. **15**–**16**;

FIG. **18** is a cross sectional view of the splice connector shown in FIG. **17** taken along line **18**—**18**;

FIG. **19** is a perspective view of another alternate embodiment of the present invention;

FIG. **20** is an end view of the splice connector shown in FIG. **19**;

FIG. **21** is a cross sectional view of the splice connector shown in FIG. **20** taken along line **21**—**21**;

FIG. **22** is a side view of another alternate embodiment of the present invention;

FIG. **23** is an end view of the splice connector shown in FIG. **22**; and

FIG. **24** is a cross sectional view of the splice connector shown in FIG. **23** taken along line **24**—**24**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, there is shown a side view of an electrical conductor splice **10** incorporating features of the present invention; shown connecting two conductors **12**, **14** to each other. Although the present invention will be described with reference to the exemplary embodiments shown in the drawings, it should be understood that the present invention can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

Referring also to FIGS. **2** and **3**, the spice connector **10** generally comprises a connector shell **16** and two wedges **18**, **19**. The connector shell **16** generally comprises a one-piece member preferably comprised of metal, such as stamped sheet metal, cast metal, or extruded and formed metal. In an alternate embodiment, the shell **16** could be comprised of more than one member. The shell **16** generally comprises a first section **20**, a second section **22**, and a middle section **24**. The first and second sections **20**, **22** form wedge receiving areas for receiving the respective wedges **18**, **19**. The middle section **24** functions as a structural bridge between the first and second sections **20**, **22**. In the embodiment shown, the middle section **24** comprises a window **26**. However, the window **26** might not be provided. The opposite side of the shell forms a generally elongate open lateral side. The shell could have any suitable length, such as 10 inches for example. The shell could be extruded with a general C shape, and then formed into the shape shown.

The first and second sections **20**, **22** are generally mirror images of each other. However, in alternate embodiments, the first and second sections could be different from each other. The first and second sections **20**, **22** comprise a general wedge shaped profile and a general cross sectional C shape. In this embodiment, the first and second sections **20**, **22** taper towards the middle section **24**. The top sides of the first and second sections **20**, **22** are substantially aligned with each other along a straight line. Each of the first and second sections **20**, **22** comprise a conductor contact surface **28** and opposing wedge contact surfaces **30**. The conductor contact surfaces **28** are located on the interior curved sides of the top sides of the first and second sections. Thus, the conductor contact surfaces **28** are substantially aligned with each other.

The two wedges **18**, **19** are substantially mirror images of each other. However, in alternate embodiments, the two wedges **18**, **19** could be different from each other. Each wedge **18**, **19** preferably comprises a one-piece member made of a suitable material, such as cast or extruded metal, for example. In an alternate embodiment, each wedge could be comprised of more than one member. Each wedge **18**, **19** comprises a first side with a conductor contact surface **32** and an opposite second side with a shell contact surface **34**. Each wedge **18**, **19** has a general wedge shaped profile between the surfaces **32**, **34** from a front end **36** to a rear end **38**. The shell contact surface on each wedge has a general curved projection profile, and the conductor contact surface on each wedge has a general groove shape.

To attach the splice **10** to the conductors **12**, **14**, the first conductor **12** is inserted into the first section **20** adjacent the conductor contact surface **28** in the first section and the first wedge **18** is inserted into the first section **20** as indicated by arrow **40**. The first wedge **18** is preferably power wedged into the first section **20** by a suitable tool, such as the tool **44** shown in FIG. **14**. However, in alternate embodiments, any suitable tool could be used to wedge the first wedge **18** into the shell **16**. One such tool is described in U.S. Pat. No. 4,722,189 which is hereby incorporated by reference in its entirety. However, any suitable type of tool for wedging a wedge into a shell could be used. The tool **44** can use an end of the window **26** as a gripping surface for the front end of the tool. When the first wedge **18** is wedged into the shell **16** by the tool **44**, the first conductor **12** is fixedly captured between the two conductor contact surfaces **28**, **32**.

The second conductor **14** is inserted into the second section **22** adjacent the conductor contact surface **28** in the second section and the second wedge **19** is inserted into the second section **22** as indicated by arrow **42**. The second wedge **19** is preferably power wedged into the second section **22** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the second wedge **19** is wedged into the shell **16** by the tool **44**, the second conductor **14** is fixedly captured between the two conductor contact surfaces **28**, **32**. The direction **40** of insertion of the first wedge **18** is reverse to the direction **42** of insertion of the wedge **19**. In this embodiment, the two directions **40**, **42** are towards each other. However, in an alternate embodiment, the two directions could be away from each other. The two conductors **12**, **14** are, thus, fixedly connected by the splice **10** in a general aligned or coaxial position. The splice **10** provides both a mechanical and a electrical connection between the two conductors **12**, **14**. If proved reliable, this design could satisfy an "ease of installation" requirement and be highly marketable if reasonably priced.

Referring now also to FIGS. **4**–**6**, one alternate embodiment of the present invention is shown. In this embodiment the splice connector **50** generally comprises two connector shells **52**, **53** and a single wedge member **54**. The two conductor shells **52**, **53** are generally mirror images of each other. However, in alternate embodiments, the two conductor shells could be different from each other. Each shell **52**, **53** comprises a general wedge shaped profile and a general cross sectional C shape. In this embodiment, the shells **52**, **53** are attached to the wedge member **54** such that the shells **52**, **53** taper towards a middle of the splice connector **50**. The top sides of the shells **52**, **53** are substantially aligned with each other along a straight line. Each of the shells **52**, **53** comprise a conductor contact surface **56** and an opposing wedge contact surface **58**. The conductor contact surfaces **56** are located on the interior curved sides of the top sides of the shells. Thus, the conductor contact surfaces **56** are substantially aligned with each other.

In this embodiment the wedge member **54** is a one-piece member made of a suitable material such as metal. The wedge member **54** comprises two end sections **60**, **62** which are connected by a middle section **64**. The two end sections **60**, **62** are substantially mirror images of each other. However, in alternate embodiments, the two end sections **60**, **62** could be different from each other. A first side of the wedge member **54** has a conductor contact surface **66** which extends along the length of the sections **60**, **62**, **64**. Each end section **60**, **62** comprises an opposite second side with a shell contact surface **34**. Each end section **60**, **62** has a general wedge shaped profile between the surfaces **66**, **34** from an outer end **68** to an inner end **70**. The two end sections **60**, **62** are tapered as they extend towards the middle section **64**.

To attach the splice **50** to the conductors **12**, **14**, the first conductor **12** is located on the conductor contact surface **66** at the first end section **60** and the first shell **52** is inserted onto the first end section **60**. The wedge member **54** is preferably power wedged into the first shell **52** by a suitable tool, such as the tool **44** shown in FIG. **14**. However, in alternate embodiments, any suitable tool could be used. The tool **44** can use the inner end of the shell as a gripping surface for the front end of the tool. When the first shell **2** is wedged with the first end section of the wedge member by the tool **44**, the first conductor **12** is fixedly captured between the two conductor contact surfaces **56**, **66**.

The second conductor **14** is inserted onto the conductor contact surface **66** at the second end section **62** and the second shell **53** is inserted onto the second end section **62**. The second shell **53** is preferably power wedged onto the second end section **62** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the second shell **53** is wedged onto the second wedge section **62** by the tool **44**, the second conductor **14** is fixedly captured between the two conductor contact surfaces **66**, **56**. The direction of mounting of the first shell **52** is reverse to the direction of mounting of the second shell **53**. In this embodiment, the two directions are away from each other. However, in an alternate embodiment, the two directions could be towards each other. The two conductors **12**, **14** are, thus, fixedly connected by the splice **50** in a general aligned or coaxial position. The splice **50** provides both a mechanical and an electrical connection between the two conductors **12**, **14**.

This design holds slightly more promise as wedge extraction would not be a problem. In addition, costs would be lessoned as only one new component (an integrated wedge) need be designed/produced. As with the integrated shell design of FIG. **1**, performance is dependent upon the C-members being able to generate enough clamping force to mechanically hold the conductor during full-tension applications. Development costs could be reduced through utilization of available conventional C-members. Installation would not be significantly more complicated than installing two tap connections. If demonstrated to be reliable and reasonably priced, this design would prove highly marketable.

Referring now also to FIGS. **7**–**9**, another alternate embodiment of the present invention is shown. In this embodiment the splice connector **72** generally comprises two connector shells **74**, **76** and a wedge member **78**. The two conductor shells **74**, **76** are generally mirror images of each other. However, in alternate embodiments, the two conductor shells could be different from each other. Each shell **74**, **76** comprises a general wedge shaped profile and a general cross sectional C shape. In this embodiment, the shells **74**, **76** are attached to the wedge member **78** such that the shells **74**, **76** taper towards a middle of the splice connector **72**. Each of the shells **74**, **76** comprise two opposing wedge contact surfaces **80**, **82**. The wedge contact surfaces **80**, **82** are located on the interior curved sides of the top and bottom sides of the shells.

In this embodiment the wedge member **78** is a multi-piece member made of a suitable material such as metal. The wedge member **78** comprises a top member **84** and a bottom member **86**. When the top and bottom members **84**, **86** are assembled, the wedge member **78** comprises two end sections **88**, **90** which are connected by a middle section **92**. The top and bottom wedge members **84**, **86** are adapted to be slidably connected to each other in a general telescoping orientation as seen best in FIG. **9**. The top of the bottom member **86** slides into a receiving area in the bottom of the top member **84**. This captures the two conductors **12**, **14** between opposing inner conductor contact surfaces **94**, **96** of the two members **84**, **86**.

To attach the splice **72** to the conductors **12**, **14**, the conductors **12**, **14** are placed between the top and bottom members **84**, **86**. The top and bottom members **84**, **86** are connected to each other to sandwich the conductors **12**, **14** between the surfaces **94**, **96**. The shells **74**, **76** are then mounted on the wedge shaped end sections **88**, **90** and wedged into a final clamping position by a suitable tool. The shells **74**, **76**, thus, keep the top and bottom members **84**, **86** clamped together to keep the conductors **12**, **14** clamped inside the wedge shaped end sections **88**, **90**.

This design addresses both the issue of wedge extraction and conductor "pull out". Although it would require development and production of an entirely new wedge design, it could utilize existent C-member components to provide required clamping forces. What is unique about this design is that the C-members would not be in direct contact with the conductors. As such, the shell's rather smooth surface would not be relied upon to mechanically hold the conductor during full-tension applications. In this proposed "integrated split wedge" design, the conductor would be captured between two inter-locking components in a scissoring or more accurately, a "guillotine clamping" effect. In this design, the C-members provide required clamping forces while contributing minimally to electrical connectivity. Also, the length (such as 10 inches for example) and ribbed contact surfaces of the split wedge would enhance conductor gripping. Electrical contact, wedge integrity, "guillotine" clamping effect and uniformity of motion during the installation process would be achieved via the interlocking "tongue & groove" design of the integrated split wedge. It is expected the proposed "integrated split wedge" would afford superior electrical performance and above-average mechanical integrity. Wedge assembly is inline with conductor run enhancing clamping forces and eliminating transverse stress concerns. A slight outer flange on the end of wedge assembly, conforming to original conductor diameter as shown in FIG. **13**, can enhance the "guillotine clamping" action and significantly inhibits extraction of distorted or expanded conductor following installation.

In this design, conductor "pull-out" is the primary concern. This might be mitigated by "ribbing" all conductor contact surfaces (in-line with stranding) in the manner illustrated in FIG. **13**. Insertion rate and resultant wiping action may be mildly diminished, but conductor "pull out" resistance should be enhanced substantially. The "ribs" can insert themselves between strands, deforming and expanding the conductor diameter. If entrance/exit holes were made to original conductor outer diameter (OD), it would seem difficult for deformed/expanded conductor ends to exit the installed connector.

Because C-members are "floating", only providing required clamping forces and not directly responsible for holding/gripping the conductor, potential for wedge extraction and conductor "pull-out" should be lessoned. This design should prove capable of being utilized as a full-tension device.

While it seems this proposed design might diminish the wiping action typically associated with fired-on wedge installations, the conductor piercing action might actually serve to disperse oxide inhibitor, create more "A" spots, enhance electrical conductivity and reduce resistance. The "guillotine" configuration of the integrated split wedge should allow for expansion/contraction of conductor in response to amperage or ambient temperature changes.

Referring now also to FIGS. **10**–**12**, another alternate embodiment of the present invention is shown. In this embodiment the splice **100** comprises a single shell **102** and two wedges **104**, **106**. The shell **102** comprises a one-piece member made of a suitable material, such as metal. The shell **102** comprises two wedge shaped end sections **108**, **110** and a middle section **112**. The two wedge shaped sections **108**, **110** are tapered in outward directions. The wedges **104**, **106** each comprise two wedge members **114**, **115** and **116**, **117**, respectively. The wedge members in each pair **114**, **115** and **116**, **117** are adapted to be slidably connected to each other in a general telescoping orientation as seen best in FIG. **12**. The bottom members **116**, **120** slide into receiving areas in the top members **114**, **118**. This captures the two conductors **12**, **14** between opposing inner conductor contact surfaces **94**, **96** of the opposing top and bottom members. The pairs of wedge members **114**, **116** and **118**, **120** are subsequently wedged into the wedge shaped end sections **108**, **110** by a suitable tool in opposite directions (outward) to fixedly clamp the wedges and conductors inside the end sections.

The proposed splice, as exemplified by this embodiment, might function better if the wedges are pointed away from the conductor ends. One might originally think, based upon prior art fired-on connectors, that designing a fired-on connector for an in-line splice was impossible because the tool would have no room to be positioned directly behind the wide part of the wedge. New users of prior art fired-on connectors are taught that, during installation, the wedge is driven into the C-body and during "take-off" the C-body is driven off the wedge. With the present invention, this process is reversed and uses the "take-off" clips to drive a C-body onto the wedge during installation. In this way, a wedge could be installed in the proposed "integrated shell" facing away from the conductor ends.

A two-piece "guillotine" inter-locking wedge assembly could be provided such as shown in FIG. **13**. In this configuration, the lateral force exerted by a full-tension application could serve to enhance the mechanical/electrical contact created by the connector. In essence, the more tension exerted, the tighter the connection made. There should be no "bird-caging" effect because the C-body is not in contact with the conductor. This design might allow one to angle or "serrate" the ribs back toward the bitter end of the conductor. In this way, any extraction forces would meet with additional resistance.

Assuming a C-member is created that is narrowed at each end, this design will function extremely well in a full-tension application. It is quite possible "drawing" of tension might accomplish wedge insertion (and desired connection) without use of an installation tooling. If so, this design could be described as a "fully-automatic" splice. If installed with WEJTAP™ tooling and "take-off" clips, a "skive" could be created in the rear side of the lower wedge component. This skive could serve to "lock" the components together creating a more homogeneous assembly and reliable connection.

Referring now to FIG. **13**, one adaptation of the conductor contact surfaces **94'**, **96'** is shown. As seen in this figure, the surfaces **94'**, **96'** comprise ridges and grooves to form opposing teeth in a conductor receiving area **122**. This illustrates that the opposing surfaces of the mating pair of wedge members, such as seen in FIGS. **9** and **12**, can have any suitably shaped surface to help grip onto the conductors **12**, **14** captured between the surfaces.

Referring now to FIGS. **15**–**18**, another alternate embodiment of the present invention is shown. The splice connector **124** generally comprises a one-piece shell **126** and two wedges **128**, **130**. The shell **126** comprises a one-piece member such as comprised of metal. The shell **126** has two wedge shaped end sections **132**, **134** and a connecting middle section **136**. Similar to the embodiment shown in FIG. **1**, the wedge shaped end sections **132**, **134** have sides **138** which are aligned with a side of the middle section to allow the conductors **12**, **14** to be aligned when connected with the splice connector. However, in this embodiment, the wedge shaped end sections **132**, **134** are tapered in outward directions.

To attach the splice **124** to the conductors **12**, **14**, the first conductor **12** is inserted into the first end section **132** adjacent the conductor contact surface in the first end section and the first wedge **128** is inserted into the first end section **132** as indicated by arrow **140**. The first wedge **128** is preferably power wedged into the first end section **132** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the first wedge **128** is wedged into the shell **126** by the tool **44**, the first conductor **12** is fixedly captured between the two conductor contact surfaces of the wedge and the shell.

The second conductor **14** is inserted into the second end section **134** adjacent the conductor contact surface in the second end section and the second wedge **130** is inserted into the second end section **134** as indicated by arrow **142**. The second wedge **130** is preferably power wedged into the second end section **134** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the second wedge **134** is wedged into the shell **126** by the tool **44**, the second conductor **14** is fixedly captured between the two opposing conductor contact surfaces on the wedge **130** and second end section **134**. The direction **140** of insertion of the first wedge **128** is reverse to the direction **142** of insertion of the second wedge **130**. In this embodiment, the two directions **140**, **142** are away from each other. The two conductors **12**, **14** are thus fixedly connected by the splice **124** in a general aligned or coaxial position. The splice **124** provides both a mechanical and a electrical connection between the two conductors **12**, **14**.

Referring now to FIGS. **19**–**21**, another alternate embodiment of the present invention is shown. In this embodiment the splice connector **144** comprises a shell **146** and two wedges **148**, **150**. The shell **146** is preferably comprised of a one-piece metal member. The shell **146** comprises a first wedge receiving section **152**, a second wedge receiving section **154**, and a connecting section **156**. The first and second wedge receiving sections **152**, **154** each have a general J shaped cross section and are angled relative to each other. In this embodiment the angle is about 90 degrees. However, in alternate embodiments, any suitable angle could be provided.

The first wedge receiving section **152** comprises a wedge shaped section **158** which tapers towards a first end of the shell. The second wedge receiving section **154** comprises a wedge shaped section **160** which tapers towards a second opposite end of the shell. The connecting section **156** has an inner surface **162** which forms a curved conductor contact surface for the conductors **12**, **14** to be clamped against.

The wedges **148**, **150** are substantially the same, but merely orientated in reverse orientations and angled 90 degrees relative to each other. The wedges **148**, **150** each comprise a wedge shaped section with a shell contacting surface **164** and an opposite conductor contacting surface **166**. Each wedge **148**, **150** also comprises a wedge slot **168** to accommodate movement of a portion of the other wedge therein.

To attach the splice **144** to the conductors **12**, **14**, the first and second conductors **12**, **14** are inserted into the shell **146** through opposite ends of the shell and are located adjacent the conductor contact surface **162** in the connecting section **156**. The first wedge **148** is inserted into the first wedge shaped section **158**. The first wedge **148** is preferably power wedged into the first wedge shaped section **158** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the first wedge **148** is wedged into the shell **146** by the tool **44**, the first conductor **12** is fixedly captured between the two conductor contact surfaces **162**, **166** of the first wedge and the shell. The second wedge **150** is inserted into the second wedge shaped section **160**. The second wedge **150** is preferably power wedged into the second wedge shaped section **160** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the second wedge **150** is wedged into the shell **146** by the tool **44**, the second conductor **14** is fixedly captured between the two conductor contact surfaces **162**, **166** of the second wedge and the shell. Because the conductors **12**, **14** are located against the same shell inner surface **162**, they are aligned relative to each other. The angled shell can allow the splice connector to be located in a uniquely shaped area and form a more compact design.

Referring now to FIGS. **22**–**24**, another alternate embodiment of the present invention is shown. In this embodiment the splice connector **170** comprises a shell **172** and two wedges **174**, **176**. The shell **172** is preferably comprised of a one-piece metal member, such as multiple member which are permanently connected to each other. The shell **172** comprises a first wedge receiving section **178** and a second wedge receiving section **180**. The shell **172** comprises a top side and a bottom side with curved walls forming inner wedge contacting surfaces **182**, **184**. The shell **172** also comprises two interior projections **186**, **188**. The projections **186**, **188** have curved shapes and form conductor contact surfaces **190**, **192**. The projections **186**, **188** are respectively located opposite the wedge contacting surfaces **182**, **184** to form the wedge receiving sections **178**, **180**. The projections **186**, **188** are angled relative to their respective opposing wedge contacting surfaces **182**, **184** to form the wedge shapes of the wedge receiving sections.

To attach the splice **170** to the conductors **12**, **14**, the first conductor **12** is inserted into the first end of the shell **172** adjacent the conductor contact surface **190** and the first wedge **174** is inserted into the first wedge receiving area **178**. The first wedge **174** is preferably power wedged into the first wedge receiving area **178** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the first wedge **174** is wedged into the shell **172** by the tool **44**, the first conductor **12** is fixedly captured between the two conductor contact surfaces **190**, **194** of the first wedge and the shell.

The second conductor **14** is inserted into the second wedge receiving area **180** adjacent the conductor contact surface **192** in the second wedge receiving area **180** and the second wedge **176** is inserted into the second wedge receiving area. The second wedge **176** is preferably power wedged into the second wedge receiving area **180** by a suitable tool, such as the tool **44** shown in FIG. **14**. When the second wedge **176** is wedged into the shell **172** by the tool **44**, the second conductor **14** is fixedly captured between the two opposing conductor contact surfaces **192**, **194** on the second wedge **176** and shell. The direction of wedging insertion of the first wedge **174** is reverse to the direction of insertion of the second wedge **176**. In this embodiment, the two directions are away from each other. The wedges are at least partially offset or misaligned from each other to allow access to the rear ends of the wedges by the installation tool. The two conductors **12**, **14** are, thus, fixedly connected by the splice **170** in a general aligned or coaxial position, but can exit the ends of the shell at an angle. The splice **170** provides both a mechanical and an electrical connection between the two conductors **12**, **14**.

The present invention can utilize fired-on wedge technology to create a highly reliable full tension splice which is quick and easy to install while remaining cost-effective. In a preferred embodiment, the wider ends of the opposing wedges are positioned inward (towards the cable break) in a manner which lateral forces might actually serve to enhance wedge insertion and the resultant mechanical/electrical and integrity.

It is assumed the reason this product has not already been created lies in an inherent inability of conventional fired-on wedge connectors to withstand "pull-out' forces generated in full-tension applications. Specifically, either the C-member is incapable of producing sufficient clamping forces to maintain mechanical hold of conductor under lateral stress, or the wedge is extracted as a result of the same forces.

The remedy, whereby the wider ends of opposing wedges are positioned inward (toward the cable break) in a manner which lateral forces might actually serve to enhance wedge insertion and resultant mechanical/electrical integrity, is rendered impossible in a conventional fired-on connector design due to the requirement to position the tool directly behind the wedge during installation. Also, introducing the wedge against the conductor stranding direction would undoubtedly create a "bird caging" problem. As such, attention was focused solely upon configurations in which the wider ends of opposing wedges were positioned outward away from the cable break. However, these problems can be overcome and the present invention can be used.

It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

What is claimed is:

1. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

a connector shell comprising a generally elongate open first lateral side; and

two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell, each wedge having a first side with a conductor contact surface and an opposite second side with a shell contact surface,

wherein the shell comprises a conductor contact section for contacting the conductors, the conductor contact section being adapted to receive two of the conductors into the shell from opposite directions in generally coaxially aligned positions, wherein the connector shell comprises two opposite ends which comprise general wedge shaped profiles orientated in general reverse directions relative to each other, wherein the connector shell comprises a middle section between the general wedge shaped profiles, and wherein the two opposite ends taper towards the middle section.

2. An electrical conductor splice as in claim **1** wherein the connector shell comprises a second opposite lateral side having at least one aperture therethrough.

3. An electrical conductor splice as in claim **1** wherein the connector shell comprises a general cross sectional C shape.

4. An electrical conductor splice as in claim **3** wherein the conductor contact section comprises a generally straight channel on a top side of the general cross sectional C shape.

5. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

a connector shell comprising a generally elongate open first lateral side; and

two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell, each wedge having a first side with a conductor contact surface and an opposite second side with a shell contact surface,

wherein the shell comprises a conductor contact section for contacting the conductors, the conductor contact section being adapted to receive two of the conductors into the shell from opposite directions in generally coaxially aligned positions, wherein the conductor contact surface on each wedge is angled relative to the shell contact surface on the wedge.

6. An electrical conductor splice as in claim **5** wherein the shell contact surface on each wedge has a general curved projection profile, and the conductor contact surface on each wedge has a general groove shape.

7. An electrical conductor splice connector shell comprising:

a first wedge receiving end section having a general wedge shaped profile; and

a second wedge receiving end section having a general wedge shaped profile, the first and second end sections being located at opposite longitudinal ends of the shell and having their wedge shaped profiles orientated in general reverse directions, wherein the shell comprises a general cross sectional C shape,

wherein the first and second wedge receiving end sections comprise a common longitudinal wall of the shell with opposite ends of the common longitudinal wall forming two conductor contact surfaces at respective ones of the wedge receiving end sections for directly contacting conductors, and wherein each wedge receiving end section comprises tapered portion opposite respective ones of the two conductor contact surfaces for directly contacting wedges inserted into the first and second wedge receiving end sections.

8. An electrical conductor splice connector shell as in claim **7** wherein the wedge shaped profiles of the first and second end sections taper in outward directions.

9. An electrical conductor splice connector shell as in claim **7** wherein the wedge shaped profiles of the first and second end sections taper in an inward direction.

10. An electrical conductor splice connector shell as in claim **7** wherein a first lateral wall of the shell is generally open and an opposite second lateral wall of the shell comprises at least one aperture therein which is located between the first and second end sections.

11. An electrical conductor splice connector shell as in claim **7** wherein a top side of the shell has a substantially straight profile.

12. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

an electrical conductor splice connector shell as in claim **7**; and

two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell.

13. An electrical conductor splice as in claim **12** wherein at least one of the wedges comprises two wedge pieces slidably connected to each other and having a conductor receiving area located between the two wedge pieces, wherein a first one of the two wedge pieces comprises a general U-shaped profile and a second one of the wedge pieces slidably extends between legs of the general U-shaped profile.

14. An electrical wedge connector splice wedge comprising:

a first end section having a general wedge shaped profile with a first conductor contact surface on a first side of the wedge; and

a second end section having a general wedge shaped profile with a second conductor contact surface on the first side of the wedge,

wherein the first and second end sections are located at opposite longitudinal ends of the wedge, and wherein their wedge shaped profiles are orientated in general reverse directions.

15. An electrical wedge connector splice wedge as in claim **14** wherein the wedge further comprises a middle section located between the first and second end sections, the middle section comprising an aperture therethrough.

16. An electrical wedge connector splice wedge as in claim **14** wherein the first side of the wedge comprises a groove therealong which forms the first and second conductor contact surfaces.

17. An electrical wedge connector splice wedge as in claim **14** wherein the wedge shaped profiles of the first and second end sections taper inward towards each other.

18. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

an electrical wedge connector splice wedge as in claim **14**; and

two electrical wedge connector shells adapted to be respectively connected to the first and second end sections of the splice wedge with the two electrical conductors to thereby wedge the two electrical conductors between the shells and the splice wedge.

19. An electrical wedge connector splice wedge comprising:

a first member having a first side and a second opposite side, the first side comprising a first electrical wedge connector splice shell contact surface, the second opposite side comprising a slot extending into the second opposite side, the slot having a first conductor contact surface therein; and

a second member movably connected to the first member, the second member extending into the slot, wherein the second member comprises a first side and an opposite second side, the first side of the second member comprising a second electrical wedge connector splice shell contact surface located in the slot, and the second opposite side of the second member comprising a second conductor contact surface, wherein the first and second conductor contact surfaces are located opposing each other.

20. An electrical wedge connector splice wedge as in claim **19** wherein the first and second members are slidably connected to each other.

21. An electrical wedge connector splice wedge as in claim **19** wherein the first member has a general cross sectional U shape.

22. An electrical wedge connector splice wedge as in claim **19** wherein the first and second members form an aperture through a middle section of the splice wedge.

23. An electrical wedge connector splice wedge as in claim **19** wherein the first and second members form a first wedge shaped end and a spaced opposite second wedge shaped end.

24. An electrical wedge connector splice wedge as in claim **19** wherein the first and second wedge shaped ends are tapered towards a middle section of the splice wedge.

25. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

an electrical wedge connector splice wedge as in claim **19**; and

two electrical wedge connector shells adapted to be respectively connected to opposite first and second end sections of the splice wedge with the two electrical conductors located between the first and second members to thereby wedge the splice wedge into the two shells to fixedly clamp the two electrical conductors between the first and second members of the splice wedge.

26. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

a connector shell comprising a generally elongate open first lateral side; and

two wedges adapted to be located in the shell at longitudinally spaced positions from each other inside opposite ends of the shell, each wedge having a first side with a conductor contact surface and an opposite second side with a shell contact surface,

wherein the shell comprises a conductor contact section for contacting the conductors, the conductor contact section being adapted to receive two of the conductors into the shell from opposite directions in generally coaxially aligned positions directly against a surface of the conductor contact section.

27. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

a connector shell; and

two wedges adapted to be located in the shell at opposite ends of the shell, each wedge having a first side with a conductor contact surface and an opposite second side with a shell contact surface,

wherein the shell comprises at least one conductor contact section for contacting the conductors, and wherein the at least one conductor contact section is adapted to receive two of the conductors in a generally aligned position at the respective opposite ends of the shell directly against a surface of the conductor contact section.

28. An electrical conductor splice as in claim **27** wherein the shell comprises a first wedge receiving area and a second wedge receiving area, and wherein the first wedge receiving area is laterally adjacent the second wedge receiving area.

29. An electrical conductor splice as in claim **27** wherein the shell comprises a first wedge receiving area and a second wedge receiving area, and wherein the first and second wedge receiving areas are partially intermixed with each other.

30. An electrical conductor splice as in claim **27** wherein the two wedges intermesh with each other.

31. An electrical conductor splice as in claim **27** wherein the at least one conductor contact section of the shell comprises two outward facing interior conductor receiving channels, and wherein the shell comprises two inward facing wedge contact surfaces opposite respective ones of the outward facing interior conductor receiving channels.

32. An electrical conductor splice as in claim **27** wherein the two opposite ends of the connector shell comprise general wedge shaped profiles.

33. An electrical conductor splice as in claim **32** wherein the general wedge shaped profiles of the two opposite ends are orientated in general reverse directions relative to each other.

34. An electrical conductor splice as in claim **33** wherein the two opposite ends taper in outward directions.

35. An electrical conductor splice for connecting at least two electrical conductors, the splice comprising:

a connector shell; and

two wedges adapted to be located in the shell at opposite ends of the shell, each wedge having a first side with a conductor contact surface and an opposite second side with a shell contact surface,

wherein the shell comprises at least one conductor contact section for contacting the conductors, and wherein the at least one conductor contact section is adapted to receive two of the conductors in a generally aligned position at the respective opposite ends of the shell,

wherein the shell comprises a first wedge receiving area and a second wedge receiving area, and wherein the first wedge receiving area is laterally adjacent the second wedge receiving area,

wherein the first wedge receiving area is angled relative to the second wedge receiving area.

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